Manitoba
Environment
and Workplace
Safety and Health

# Monitoring for Malathion Residues in Lettuce, Onions and Fruit, After Aerial Spraying in Southern Manitoba, 1983.

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## ABSTRACT

Urban centres in Southern Manitoba, Canada were sprayed with malathion to combat a potential epidemic of Western Equine Encephalitis. A specially equipped aircraft was used to apply ultra low volume insecticide at a rate of 210 mL/ha.

A study was undertaken to determine the degree to which vegetables and fruit grown in backyard gardens might be contaminated by the malathion. Samples of lettuce, green onion tops, strawberries, raspberries and apples were collected before and immediately after the aerial spraying. The samples were quick-frozen and stored at -45°C. A gas chromatograph with a flame-photometric detector (phosphorus mode) was used to analyze the samples after appropriate preparation.

More than 50 percent of the unwashed post-spray samples of lettuce and green onion tops exceeded the tolerable levels of 6.0 µg/g and 3.0 µg/g respectively. Malathion concentrations in fruit were less than 1.0 µg/g, well below the tolerable limit of 8.0 µg/g. Washing the lettuce samples reduced malathion residues to well below 6.0 µg/g. Field weathering reduced the malathion concentration in lettuce by 50 percent in the first 48 hours after application and the residue was almost totally dissipated after 14 days. No foliage damage attributable to malathion was observed.

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# I INTRODUCTION

On July 19, 1983, the Minister of Health, Province of Manitoba, declared a health emergency in Southern Manitoba because of a potential epidemic of Western Equine Encephalitis (WEE). As a result, an emergency aerial spraying program using the insecticide malathion was initiated to control adult mosquito populations of Culex tarsalis, the principal transmitter of the WEE virus. At the same time the Minister of the Environment announced that the Province of Manitoba would initiate a multi-facetted monitoring program to evaluate the aerial application of malathion. This report provides results of the vegetable and fruit monitoring program carried out by the Terrestrial Standards and Studies Section. The program was established to determine whether the malathion was contaminating human food, in particular, vegetables and fruit grown in backyard gardens.

Leaf lettuce was chosen as the primary sampling substrate because: (i) it was grown in most gardens and therefore was readily available, (ii) it had a relatively large surface area, a pre-requisite of a good receptor, (iii) the edible parts of the plant are exposed to the spray (iv), lettuce is eaten with no preparation except washing and (v) the analysis for contaminants is simplified because lettuce does not contain compounds which could interfere in the chemical analysis procedure. Samples of other substrates (onion, strawberry, raspberry and apple) were collected from a few locations for comparison.

A considerable amount of information appears in the literature concerning residues of several insecticides used in conventional crop spraying. Some studies have focused on malathion residues in crops and in soils but specific testing of residues in vegetables and fruits following ultra low volume applications by aircraft have not been reported. Conventional spraying of malathion, results in increased pesticide residues in lettuce, green onions, raspberries and apples (Kansouh et al. 1978, Smith et al. 1954, Wallis et al. 1957, Westlake and Butler 1953). Relevant studies of residues on leafy vegetables include that of Waites and Van Middelem (1957) on cabbage. Conventional spraying resulted in application rates which were 3 to 8 times higher than ultra low volume aerial spraying; nevertheless, the data are useful for comparative purposes.

## II METHODS

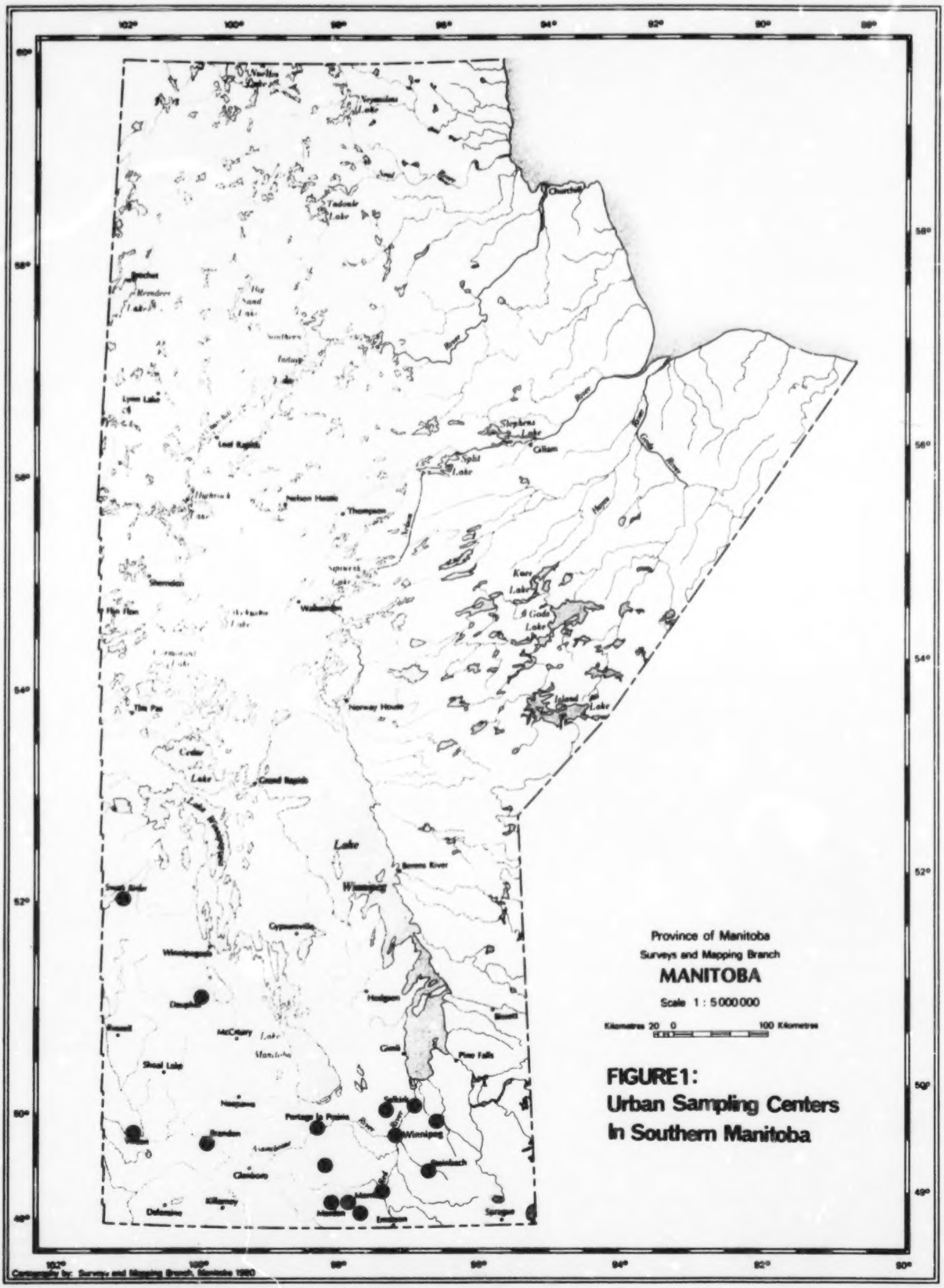
### A. Aerial Spraying

Cythion Ultra Low Volume (ULV) concentrate which is composed of 95% malathion, was chosen as the spraying agent. A specially equipped Conair DC6B aircraft was contracted to carry out the aerial spraying. Malathion application rate was 210 mL per hectare (3 fl. oz./acre); the aircraft flew at an altitude of 100 metres and a speed of

150 knots per hour. Flight lines were perpendiculer to prevailing wind directions and were spaced at 0.8 km (0.5 miles) intervals. All spray applications were carried out in early morning or late evening when adult mosquitoes were theoretically most active. Spraying was restricted to those mornings and evenings when the wind speed was less than 16 km/h.

## B. Vegetable and Fruit Sampling

The monitoring program was limited to lettuce, green onion tops, strawberries, raspberries and apples. The sampling was conducted in 15 cities/towns in Southern Manitoba (Figure 1) where the spraying occurred (See Appendix 1 for maps showing site locations). Samples were collected for each of the two spray events in Winnipeg. As much as possible, work associates or acquaintances of Terrestrial Standards and Studies staff were contacted in various areas of each city/town and asked if they would assist by allowing us to sample in their garden. If the first contact did not have lettuce in their yard, they would usually refer us to someone on their street who did. In communities where there was no known contact, the staff in Manitoba Agriculture regional offices assisted by contacting their work associates or acquaintances. In at least four towns, there was insufficient lead time to set this contact process in motion. In those cases, we selected neighbourhoods and canvassed homes until we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Thompson
Nelson House
Gillam
Split Lake
Stephens Lake
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Knee Lake
Gods Lake
Island Lake
The Pas
Cedar Lake
Grand Rapids
Lake Winnipeg
Berens River
Swan River
Cypress River
Winnipegosis
Dauphin
Hodgson
Bissett
Russell
McCreary
Lake Manitoba
Gimli
Pine Falls
Shoal Lake
Neepawa
Selkirk
Portage la Prairie
Winnipeg
Virden
Brandon
Steinbach
Glenboro
Killarney
Deloraine
Morden
Emerson
Sprague
Cartography by: Surveys and Mapping Branch, Manitoba 1980

**FIGURE1:
Urban Sampling Centers
In Southern Manitoba**

found a resident with lettuce in their garden. We received excellent cooperation from the public and without exception, all who had lettuce were willing to participate.

Onions, raspberries and apples were sampled from a few locations, the selection process being dependent for the most part on availability. Strawberries were sampled from four U-Pick strawberry farms which were within the designated spray blocks.

Pre-spray samples were collected before the spraying occurred to determine the background levels in each garden. Sampling was carried out between 20 minutes and 2 hours of the time that the spray plane passed each sample location. If we were on-site when a given location was sprayed, we would delay sampling for 20 minutes to allow the malathion to settle. The logistics of ground travel made it impossible to keep up to the aircrafts progress so locations sprayed later in a spray event could not be sampled immediately. Although it was usually possible to sample within one hour, delays of up to two hours occurred at a few sites.

Four gardens in Winnipeg were monitored over a longer post-spray duration; a second sample was collected 2 to 5 days after spraying and the third and fourth samples at 7 and 14 days respectively. The purpose of this "extended" monitoring was to study the rate of malathion degradation under field conditions.

Sample collection involved snapping leaves off the lettuce plants with our fingers, at random along a row, until the required sample (30 grams minimum) was obtained. Two samples (unwashed and washed) were collected from each garden provided that enough lettuce was available. Only washed samples were collected from gardens which had a limited supply of lettuce. Washing involved alternately rinsing with tap water and squeezing the water out, a process which was repeated 5 times. All samples were placed in 500 mL glass jars with screw caps. The jars had been pre-cleaned with acetone and hexane and the caps were lined with acetone/hexane-washed aluminum foil.

Onions were sampled in a similar way to the lettuce, by snapping leaves off at random along a row until the necessary sample was obtained. Only unwashed onion samples were collected. Strawberries and raspberries were sampled by picking ripe fruit at random along both sides of a row until the necessary sample was accumulated. Similarly, apples were sampled by selecting fruit at random from various parts of a tree. The apples were still green in July when the sampling occurred. All strawberry, raspberry and apple samples were collected in the unwashed condition.

The samples were frozen within 5 minutes of collection, by placing them in a cooler lined with dry ice (-78°C). The purpose of the low temperature quick-freezing was to prevent the breakdown of malathion.

Studies of malathion degradation at different storage temperatures suggest that breakdown can be rapid at temperatures above 0°C (Koivistoinen et al. 1964 a). Studies of degradation at -18°C were inconclusive but the potential for malathion degradation at that storage temperature was not ruled out (Koivistoinen et al. 1964 b). Our study proposed much lower storage temperatures as an additional measure of protection. The samples were transported to a -40°C freezer at the Ellice Building, University of Manitoba for initial storage but were subsequently transferred to a -45°C freezer at the Fresh Water Institute.

The analyses were carried out by the W. M. Ward Technical Services Laboratory. A 30-gram subsample of the frozen sample was homogenized with acetonitrile, and after appropriate dilution with water, was partitioned with petroleum ether. The petroleum ether extract was then dried through $Na_2SO_4$ and concentrated. The extract was then analyzed using a gas chromatograph equipped with a flame photometric detector in the phosphorous mode (U.S. Food and Drug Administration 1982). Results were confirmed on two detectors and a GC mass spectrophotometer was used to confirm the malathion compound in one of the samples. A subsample of uncontaminated lettuce from La Riviere was analyzed with each batch of 10 samples as a quality assurance check. A further quality assurance check was implemented with each batch, by analyzing a subsample of the uncontaminated lettuce which had been spiked with a known quantity of malathion. The mean analytical recovery rates were 91 percent and 96 percent at concentrations of 0.015 ng/μL and 0.15 ng/μL respectively.

## III RESULTS AND DISCUSSION

### A. Spray Application Rate

The ultra low volume application rate of malathion was 210 mL/ha. However, there was considerable variability in the amount which reached the ground. The Environmental Protection Service, Environment Canada, carried out a droplet monitoring program and observed deposition ranging from 1 mL/ha to 354 mL/ha (Youmans 1983).

### B. Vegetable and Fruit Monitoring

A total of 249 lettuce samples, 28 green onion samples, 8 strawberry samples, 11 raspberry samples and 10 apple samples were analyzed in the course of this monitoring program. Results for each sample substrate will be dealt with separately in the discussion which follows.

#### 1. Lettuce

Concentrations of malathion found in pre-spray compared with post-spray lettuce samples from the City of Winnipeg are presented in Table 1. Data from other cities and towns in Southern Manitoba are shown in Table 2. Before the first spray event, low levels of malathion (<0.002 µg/g to 0.065 µg/g) were present in unwashed lettuce from backyard gardens in Winnipeg. The average concentration

(Table 3) before the first spray event was 0.018 µg/g in Winnipeg compared with 0.035 µg/g for lettuce from other cities/towns in Southern Manitoba. Washing the lettuce reduced average pre-spray concentrations of malathion to 0.005 µg/g and 0.002 µg/g for Winnipeg and Southern Manitoba respectively.

Comparison of the average malathion concentrations in Winnipeg before the first and the second spray event suggest that malathion levels had increased. However there is no proof that malathion residues from the first spray event caused the increase; natural variablity in the data was high and could account for the small differences noted.

Applications of malathion by aerial spraying resulted in elevated concentrations of malathion in approximately 50 percent of the lettuce samples. The data were highly variable, ranging from pre-spray background levels of <0.002 µg/g to a high of 24.6 µg/g. This is consistent with the variability in measured deposition rates which ranged from 1 mL/ha to 354 mL/ha (Youmans 1983). Some variability in deposition was expected because the flight lines were spaced at 0.8 km (0.5 mi) intervals and variable atmospheric influences such as wind and thermal gradients, as well as the effects of surface topography and landscape structures, could have affected the spray drift.

The post-spray unwashed lettuce sample from site 9, in the Point Douglas area of Winnipeg, had a malathion concentration of 78.4 µg/g which appears to be an anomaly in that it was three times higher than the next largest concentration. However, re-analysis of the sample on the gas chromatograph confirmed the concentration, and follow up analysis by GC mass spectrophotometry positively identified the presence of high levels of malathion. The reason for the high deposition at site 9 is not known. A malfunctioning nozzle could have been suspected if the site had been directly below a flight line but in fact it was located between flight lines. The other possibility is that the combination of wind direction, wind speed, and the influence of tall trees, two storey houses and the proximity of the Red River with its associated flood control dyke, could have combined to funnel air currents to the site. In any case, the 78.4 µg/g value was an obvious outlier and was not used in the calculation of mean values.

Even though site 11 - Winnipeg and site 1 - Selkirk were beyond the boundaries of prescribed spray blocks (approximately 2 km north), slightly elevated levels of malathion were found in post-spray samples of lettuce. It appears from these data that spray drift may carry the malathion up to 2 km beyond the designated spray boundaries.
Site 1 - Selkirk was downwind of the Selkirk spray block so the drift was not unexpected, however, site 11 - Winnipeg was slightly upwind of the Winnipeg spray block but was still affected.

The average post-spray concentration in unwashed lettuce from Winnipeg was 6.66 µg/g (range 0.164 to 15.6 µg/g) for the first spray event, 7.39 µg/g (range 0.093 to 24.6 µg/g) for the second spray event and 7.38 µg/g (range <0.002 to 24.6 µg/g) for other cities/towns in Southern Manitoba (Table 3). After the first Winnipeg spray event, 50 percent of the unwashed lettuce samples exceeded the tolerable level of 6.0 µg/g for malathion in lettuce (Health and Welfare Canada, Food and Drug Directorate 1975). Similarly, 43 percent of the samples from the second Winnipeg spray event and 52 percent of post-spray samples from other cities/towns had concentrations of malathion exceeding 6.0 µg/g.

The malathion residues found in lettuce compare well with other published reports. Smith et al. (1954) found malathion residues of up to 22 µg/g following fumigation with a 15 percent aerosol at a rate of 1.5 g/1000 cu ft. Assuming that the height of the greenhouse was 10 feet, the rate of application would have been 1.5 g/100 sq. ft. or 1313 mL/ha. Wallis et al. (1957) applied malathion at a rate of 1.75 lb./acre (1595 mL/ha) to lettuce; the resulting one hour post-spray residue of malathion was 26.1 µg/g. Kansouh et al. (1978) reported much higher residues of 91 µg/g following the application of 57 percent malathion (emulsifiable concentrate) at a rate of 1.0 L/feddan (equivalent to 1356 mL/ha active ingredient). The ultra low volume application rate in Manitoba's aerial spraying program was much lower (210 mL/ha) but some samples had residues as high as those reported by Smith et al. (1954) and Wallis et al. (1957). This probably resulted from the higher than prescribed spray deposition in some areas, a fact which is supported by the droplet monitoring results (Youmans 1983).

Although malathion residues in some unwashed lettuce were too high for safe human consumption, a simple water washing proved to be effective in reducing concentrations to acceptable levels. The average concentration in washed lettuce from Winnipeg was 0.85 µg/g and 1.72 µg/g for the first and second spray events respectively; that from Southern Manitoba was 0.83 µg/g. This agrees with evidence presented by Wallis et al. (1957) wherein the malathion residues in parsley were reduced from 36 to 3 µg/g by washing for 1 minute. Some of the residue is rinsed off the plant material but the process of hydrolysis may also degrade some of the malathion, especially at strongly basic pH's (Cowart et al. 1971 and Konrad et al. 1969).

The data presented in Table 4 demonstrate the natural degradation rate of malathion in lettuce after the spray event. Sites 8 and 10 (Winnipeg) provide the best examples because the data are complete. At site 10, the malathion concentration in unwashed lettuce was reduced from 8.8 µg/g to 1.74 µg/g over a two day period. At site 8, the percentage decrease was less, but within two days, natural degradation was effective in reducing the level below the tolerable limit of 6.0 µg/g. Degradation of malathion continued through the 14 day test period, resulting in final concentrations which were within the pre-spray background range. These data also show that even when very little malathion was present, washing the lettuce was still effective in reducing the concentration.

Other studies support the evidence that residues of malathion dissipate fairly rapidly with time after application. For the outside leaves of cabbage, Waites and Van Middelem (1957) found that 40 percent dissipated within 48 hours and 80 percent after 7 days. Similar results were obtained in the studies of Smith et al. (1954). Wallis et al. (1957) determined natural degradation of malation in lettuce to be 50 percent over a seven day period. In most instances, concentrations are reduced to near zero after 14 days (Smith et al. 1954). More recently, Kansouh et al. (1978) reported a 50 percent reduction of malathion residues in lettuce within 3 to 5 days and further decreases at the 7 and 9 day post-application intervals. However, the initial deposit was 4 to 5 times those of Wallis et al. (1957) and Smith et al. (1954). As a result, the 9 day residue was relatively high (22 to 24 µg/g). If the plants are growing vigorously, the increase in weight could account for some of the reduction in malathion levels. In the present study, the lettuce which was tested over the two week period was mature and not growing rapidly. We believe that malathion degradation rather than the inclusion of new growth was the predominant factor operating to reduce concentrations over time.

### 2. Onions

Unwashed green onion tops were sampled from 14 gardens to compare malathion concentrations with those found in lettuce (Table 5). The pre-spray samples had low malathion levels which were usually below the detection limit of 0.002 µg/g. Fifty-eight percent of the post-spray samples exceeded the tolerable level of 3.0 µg/g for malathion in onions (Health and Welfare Canada, Food and Drug Directorate 1975). The mean concentration of malathion in unwashed pre-spray samples was 0.003 µg/g and that in samples collected within one hour of the aerial spray application was 4.9 µg/g (range 0.01 µg/g to 15.5µg/g). Although washed post-spray onion samples were not tested, we feel that washing would probably have reduced the malathion concentrations to below the 3.0 µg/g tolerance limit. Washing the sample not only rinses some of the malathion off the plant material but may also promote some hydrolysis of malathion residues (Smith et al. 1954, Konrad et al. 1969 and Cowart et al. 1971).

With the exception of three sites, there was generally good agreement between the malathion in onions and that in lettuce from the same garden. The concentrations were usually slightly lower in the onion tops which might be explained by the greater mass per unit area of the receptor surface. Onions from site 10 in Winnipeg and site 4 in Carman had less than 10 percent of the malathion concentrations that were found in the lettuce samples. On the other hand, onions from site 4 in Brandon, had malathion levels more than twice that of lettuce from the same garden. We do not know the cause of those anomalies.

Smith et al.(1954) reported a malathion concentration of 10.56 µg/g in green onion tops which had been sprayed with malathion (emulsifiable concentrate) at 911 mL/ha (1 lb/acre). Their application rate was four times the rate of 210 mL/ha which was applied in the Manitoba aerial spraying program reported herein. It is obvious from the site-to-site variability in our data that the spray distribution at ground level was not uniform. Given the fact that some sites may have received very little malathion while others may have received more than the prescribed application, the present data seem to coincide fairly well with those reported by Smith et al. (1954).

### 3. Strawberries, Raspberries and Apples

Pre-spray malathion concentrations in strawberries were below the detection limit of 0.002 µg/g (Table 6). Malathion concentrations in post-spray samples were slightly elevated with an average of 0.251 µg/g and a range of 0.036 to 0.706 µg/g. Similar results were obtained from the raspberry samples; the mean post-spray concentration was 0.254 µg/g with a range of 0.053 to 0.444 µg/g. Apples on the other hand had relatively low post-spray malathion residues with a mean of 0.052 µg/g and a range of 0.002 to 0.109 µg/g. No data on residues in these fruit crops following ultra low volume aerial application have been reported in the literature. Studies using conventional spray applications of malathion as emulsifiable concentrate (E.C.) have reported higher residues but that could be attributed to the higher rates of application and the different spray angle.

Wallis et al. (1957) found residues in red raspberry ranging from 4.0 to 9.8 µg/g within one hour of the application of 1.75 lb/acre (1595 mL/ha) of malathion (E.C.). That was 8 times higher than the ultra low volume application of 210 mL/ha in the present study. Furthermore, in our study, the leaves of the raspberry probably protected the fruit from direct deposition of the spray. The spray from hand sprayers, as per Wallis et al. (1957), would have increased the probability of direct contact because the nozzle would have been directed horizontally, and at that angle the foliage would not provide as much protection to the fruit.

Westlake and Butler (1953) studied malathion residues in apple fruit after it was sprayed with an emulsifiable concentrate at different concentrations. At a rate of 0.31 lb per 100 gal, the residue was 1.0 µg/g and at 0.5 lb/100 gal, the residue ranged from 1.0 to 1.2 µg/g. The low residues which were found on apples in the present study are attributed to lower application rates plus the nearly vertical deposition. With aerial spray, the leaves provide more protection to the fruit compared with the more horizontal application by conventional sprayers.

There are no published data on residues of malathion in strawberries. In the present study, concentrations were similar to those found in raspberries. Because the fruit is usually under the leaves, it is protected to some degree from direct contact by the aerially applied malathion.

The concentration of malathion in strawberrios and raspberries was much lower than that found in lettuce and onions. Two probable factors which combined to produce that result are: (i) the fruit was usually under the leaves and was thus protected (ii) the fruit had a greater mass per unit surface area than lettuce or onions and thus the concentration was lower. The fact that apples have a much higher ratio of mass to surface area than small fruits probably explains why apples had the lowest residues.

## C. Malathion Phytotoxicity

While revisiting gardens after the spray application, the plant material was examined to see if the spray had caused any phytotoxic symptoms such as leaf-burn, leaf curling or abnormal leaf drop. There were no observed phytotoxic symptoms at the sample gardens. Furthermore, detailed examination of plants in other gardens, where the residents feared that malathion damage had occurred, revealed that powdery mildew as well as insects such as spider mites, aphids, and flea beetles had caused the foliage symptoms.

## IV CONCLUSIONS

1. Aerial application of malathion to control a potential outbreak of Western Equine Encephalitis caused concentrations of the insecticide in unwashed lettuce to exceed the tolerable level established by Health and Welfare Canada.

2. The deposition of malathion was highly variable, but up to 52 percent of lettuce had been contaminated above the tolerable concentration of 6.0 µg/g.

3. Actual malathion concentrations range to 3 or 4 times the guideline with unexpected frequency, and one lettuce sample had an inexplicably high concentration of 78.4 µg/g.

4. Washing the lettuce was effective in reducing the malathion concentrations well below the tolerable limit.

5. Natural degradation of malathion was rapid, resulting in a 50% reduction in the initial 48 hour period and almost total degradation within 14 days.

6. Green onion tops generally contained lower malathion residues than lettuce but since the tolerable limit for onions is lower e.g. 3.0 µg/g, 58 percent of the unwashed samples exceeded the Health and Welfare Canada guideline.

7. Malathion residues in unwashed strawberries, raspberries and apples were well below 1.0 µg/g which provides a good safety margin relative to the tolerable limit of 8.0 µg/g. Protection by foliage and a higher mass to surface area ratio are cited as factors contributing to the lower malathion concentrations in fruits.

8. There were no observed cases where the ultra low volume application of malathion caused visible damage to plant foliage.

TABLE 1: Malathion concentration (µg/g) in lettuce samples collected from backyard gardens in Winnipeg.

| Site | First Spray Event | | | | Second Spray Event | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Spray | | Post-Spray | | Pre-Spray | | Post-Spray | |
| No. | unwashed | washed | unwashed | washed | unwashed | washed | unwashed | washed |
| 1 | 0.012 | <0.002 | – | 0.471 | 0.008 | 0.003 | 5.31 | 0.617 |
| 2 | <0.002 | <0.002 | – | 0.216 | – | <0.002 | – | 0.215 |
| 3 | <0.002 | <0.002 | – | 0.711 | – | – | – | – |
| 3* | – | – | – | – | – | 0.007 | – | 0.090 |
| 4 | 0.005 | <0.002 | – | 0.084 | 0.008 | 0.041 | 24.6 | 7.86 |
| 5 | 0.055 | 0.005 | 15.6 | 1.95 | 0.012 | <0.002 | 1.09 | 0.295 |
| 6 | 0.065 | 0.010 | 2.58 | 0.319 | 0.005 | 0.002 | 0.170 | 0.066 |
| 7 | 0.038 | 0.003 | 4.38 | 0.184 | – | – | – | – |
| 7* | – | – | – | – | – | 0.005 | – | 1.83 |
| 8 | – | – | 0.164 | 0.136 | 0.052 | 0.004 | 11.7 | 4.02 |
| 9 | 0.002 | 0.002 | 78.4** | 0.605 | – | – | – | – |
| 9* | – | – | – | – | 0.031 | 0.006 | 0.093 | 0.073 |
| 10 | <0.002 | <0.002 | 10.6 | 1.98 | 0.042 | 0.009 | 8.80 | 3.24 |
| 11*** | <0.002 | <0.002 | 0.132 | 0.122 | <0.002 | 0.087 | 0.042 | 0.052 |
| 12 | <0.002 | 0.020 | – | 2.70 | – | 0.012 | – | 0.584 |
| Mean | 0.018 | 0.005 | 6.66 | 0.85 | 0.022 | 0.008 | 7.39 | 1.72 |

* – Alternate for second spray event.
** – Outlier, not included in calculations
*** – Outside of designated spray block; data not used in calculation of means or percentages

TABLE 2. Malathion concentration (µg/g) in lettuce samples from backyard gardens in cities/towns in Southern Manitoba (excluding Winnipeg)

| | | Pre-Spray | | Post-Spray | |
|---|---|---|---|---|---|
| City/Town | Site No. | Unwashed | Washed | Unwashed | Washed |
| Altona | 1 | <0.002 | <0.002 | 0.033 | 0.012 |
| | 2 | <0.002 | <0.002 | 0.023 | 0.009 |
| | 3 | <0.002 | <0.002 | 0.008 | 0.011 |
| Beausejour | 1 | <0.002 | <0.002 | 15.3 | 1.00 |
| | 2 | <0.002 | <0.002 | 10.0 | 0.768 |
| | 3 | <0.002 | <0.002 | 20.6 | 0.519 |
| Brandon | 1 | <0.002 | 0.004 | 1.57 | 0.452 |
| | 2 | <0.002 | <0.002 | 7.28 | 1.76 |
| | 3 | <0.002 | 0.002 | 12.3 | 2.85 |
| | 4 | <0.002 | 0.003 | 6.44 | 1.81 |
| Carman | 2 | <0.002 | 0.003 | 10.9 | 0.460 |
| | 3 | <0.002 | <0.002 | 3.36 | 0.172 |
| | 4 | <0.002 | <0.002 | 14.6 | 0.575 |
| Dauphin | 1 | 0.002 | <0.002 | 3.02 | 0.752 |
| | 2 | 0.002 | <0.002 | 3.02 | 0.752 |
| | 3 | 0.003 | 0.003 | 8.42 | 1.27 |
| | 4 | 0.003 | 0.003 | 11.4 | 0.436 |
| Morden | 1 | <0.002 | <0.002 | 14.8 | 1.20 |
| | 3 | <0.002 | <0.002 | 2.62 | 0.159 |
| Morris | 1 | <0.002 | 0.002 | 4.36 | 1.18 |
| | 2 | <0.002 | <0.002 | 9.99 | 1.14 |
| Portage la Prairie | 1 | 0.004 | <0.002 | 1.69 | 0.273 |
| | 2 | 0.002 | <0.002 | 1.14 | 0.406 |
| | 3 | 0.007 | <0.002 | 0.551 | 0.171 |
| | 4 | <0.002 | <0.002 | 0.843 | 0.166 |
| Selkirk | 1* | 0.004 | <0.002 | 0.180 | 0.221 |
| | 3 | <0.002 | <0.002 | 24.6 | 0.973 |
| | 4 | <0.002 | <0.002 | 8.35 | 1.01 |
| Steinbach | 1 | <0.002 | 0.010 | 1.79 | 0.347 |
| | 2 | <0.002 | <0.002 | <0.002 | <0.002 |
| | 3 | <0.002 | <0.002 | <0.002 | <0.002 |
| Stonewall | 1 | <0.002 | <0.002 | 0.372 | 0.198 |
| | 2 | <0.002 | <0.002 | 2.30 | 0.418 |
| | 3 | <0.002 | <0.002 | 10.6 | 2.68 |
| Swan River | 1 | 0.002 | <0.002 | 7.59 | 0.823 |
| | 2 | <0.002 | <0.002 | 19.6 | 1.63 |
| | 3 | 0.002 | 0.002 | 13.2 | 0.650 |
| Virden | 1 | 0.004 | <0.002 | 9.02 | 1.21 |
| | 2 | 1.33 | 0.005 | 3.81 | 0.524 |
| Winkler | 1 | <0.002 | <0.002 | 18.8 | 2.94 |
| | 2 | <0.002 | <0.002 | 10.5 | 0.852 |
| | 3 | <0.002 | <0.002 | 7.58 | 1.57 |
| Mean | | 0.035 | 0.002 | 7.38 | 0.83 |

* Site outside of designated spray block; Data not used in calculation of mean or percentages.

TABLE 3: Average concentrations of malathion in lettuce with associated ranges (µg/g).

| | Pre-spray | | | | Post-spray | | | |
|---|---|---|---|---|---|---|---|---|
| | Unwashed | | Washed | | Unwashed | | Washed | |
| Location/Description | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| **First Spray Event** | | | | | | | | |
| Winnipeg | 0.018 | <0.002 - 0.065 | 0.005 | <0.002 - 0.020 | 6.66* | 0.164 - 15.6* | 0.85 | 0.084 - 2.70 |
| Southern Manitoba ** | 0.035 | <0.002 - 1.33 | 0.002 | <0.002 - 0.010 | 7.38 | <0.002 - 24.6 | 0.83 | <0.002 - 2.94 |
| **Second Spray Event** | | | | | | | | |
| Winnipeg | 0.022 | 0.005 - 0.052 | 0.008 | <0.002 - 0.041 | 7.39 | 0.093 - 24.6 | 1.72 | 0.066 - 7.86 |

*Excluding outlier value of 78.4 ug/g.

**Not including City of Winnipeg.

**TABLE 4: Post-spray degradation of malathion in lettuce under field conditions.**

| Site | 1 hour | | 2-5 days | | 7 days | | 14 days | |
|---|---|---|---|---|---|---|---|---|
| No. | UW | W | UW | W | UW | W | UW | W |
| 2 | – | 0.215 | 0.207(5) | 0.116 | 0.007 | – | <0.002 | – |
| 8 | 11.7 | 4.02 | 5.53(2) | 0.753 | 0.061 | 0.024 | 0.016 | 0.008 |
| 10 | 8.80 | 3.24 | 1.74(2) | 0.467 | 0.013 | 0.008 | 0.005 | – |
| 12 | – | 0.584 | 0.090(4) | 0.013 | 0.199 | <0.002 | 0.048 | 0.003 |

( ) Days since malathion spray application.
UW - unwashed sample.
W - washed sample.

**TABLE 5.** Malathion concentration (µg/g) in unwashed pre and post-spray samples of green onion tops compared with that in unwashed post-spray samples of lettuce from corresponding gardens.

| City/Town | Site No. | Onions | | Lettuce |
|---|---|---|---|---|
| | | Pre-Spray | Post-Spray | Post Spray |
| Altona | 1 | <0.002 | 0.010 | 0.033 |
| Beausejour | 1 | <0.002 | 10.7 | 15.3 |
| Brandon | 3 | 0.005 | 9.69 | 12.3 |
| | 4 | <0.002 | 15.5 | 6.44 |
| Carman | 4 | <0.002 | 0.814 | 14.6 |
| Morden | 2 | <0.002 | 3.75 | - |
| Morris | 1 | <0.002 | 3.55 | 4.36 |
| Portage la Prairie | 1 | <0.002 | 2.67 | 1.69 |
| Selkirk (E) | 1* | <0.002 | 0.303 | 0.180 |
| Stonewall | 1 | 0.004 | 0.219 | 0.372 |
| Virden | 2 | 0.006 | 3.71 | 3.81 |
| Winkler | 2 | <0.002 | 7.27 | 10.50 |
| Winnipeg | 10 | <0.002 | 0.909 | 10.6 |
| | 11* | <0.002 | 0.160 | 0.132 |
| Mean | | 0.003 | 4.90 | |

* Sites outside of prescribed spray block; Data not used in calculation of means or precentages.

TABLE 6. Malathion concentration (μg/g) in unwashed pre- and post-spray samples of strawberries, raspberries and apples.

| Fruit | City/Town | Site No. | Pre-Spray | Post-Spray |
|---|---|---|---|---|
| Strawberries | Carman | 1 | <0.002 | 0.036 |
| | Portage la Prairie | 5 | <0.002 | 0.036 |
| | East Selkirk | 2 | <0.002 | 0.228 |
| | | 5 | <0.002 | 0.706 |
| | | Mean | 0.002 | 0.251 |
| Raspberries | Brandon | 1 | <0.002 | 0.444 |
| | | 3 | <0.002 | 0.155 |
| | Carman | 4 | <0.002 | 0.053 |
| | Portage la Prairie | 1 | <0.002 | 0.129 |
| | Virden | 2 | <0.002 | 0.444 |
| | Winkler | 2 | - | 0.298 |
| | | Mean | 0.002 | 0.254 |
| Apples | Altona | 3 | <0.002 | 0.002 |
| | Carman | 2 | <0.002 | 0.083 |
| | Stonewall | 3 | <0.002 | 0.060 |
| | Winkler | 2 | <0.002 | 0.109 |
| | Winnipeg | 2 | <0.002 | 0.005 |
| | | Mean | 0.002 | 0.052 |

## ACKNOWLEGEMENTS

We wish to thank all homeowners and strawberry growers who participated in this study by willingly providing permission for access and sampling on their properties. We also express our gratitude to the many individuals who assisted by identifying/contacting residents who were willing to participate and to the Manitoba Cooperative Dairy in Dauphin and the Elkhorn Ranch Hotel in Riding Mountain National Park for allowing us to store samples in their freezers.

We are grateful to the Pesticide Research Laboratory, Department of Soil Science, University of Manitoba, who on request, generously apprised us of their information base with respect to sample handling and storage as well as analytical technology. That information assisted in the development of methods used in this vegetable and fruit monitoring program. We also wish to thank the Pesticide Research Laboratory for providing interim freezer storage for the samples.

In addition, we acknowledge the contribution of the Fresh Water Institute, Fisheries and Oceans, Environment Canada, who provided freezer storage facilities.

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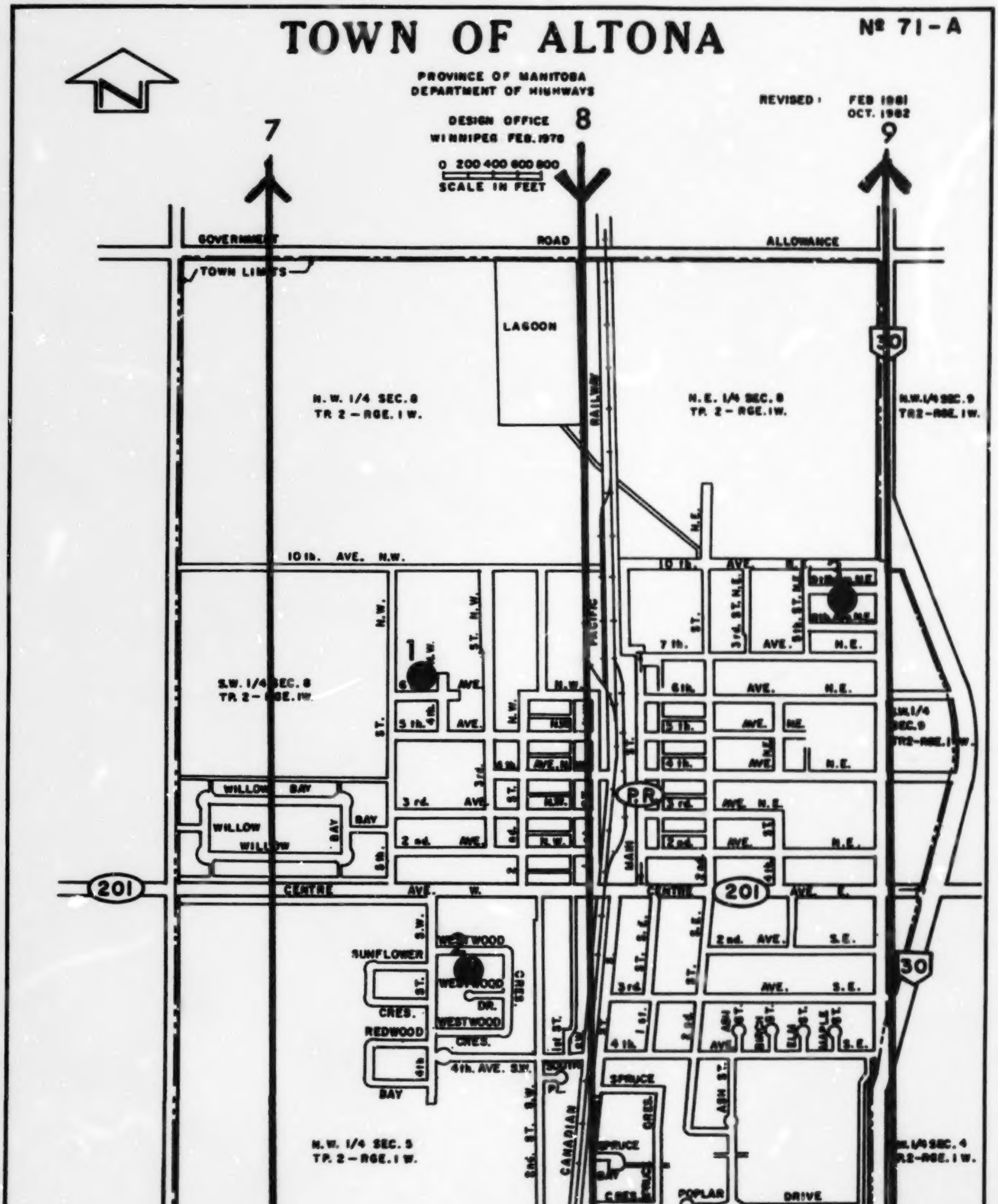
# APPENDIX 1

Maps of 15 cities and towns in Southern Manitoba
showing sample site locations and the
approximate position of aerial spray flight lines.

# MAP LEGEND

→— - AERIAL SPRAY FLIGHT LINES

● - SAMPLE LOCATIONS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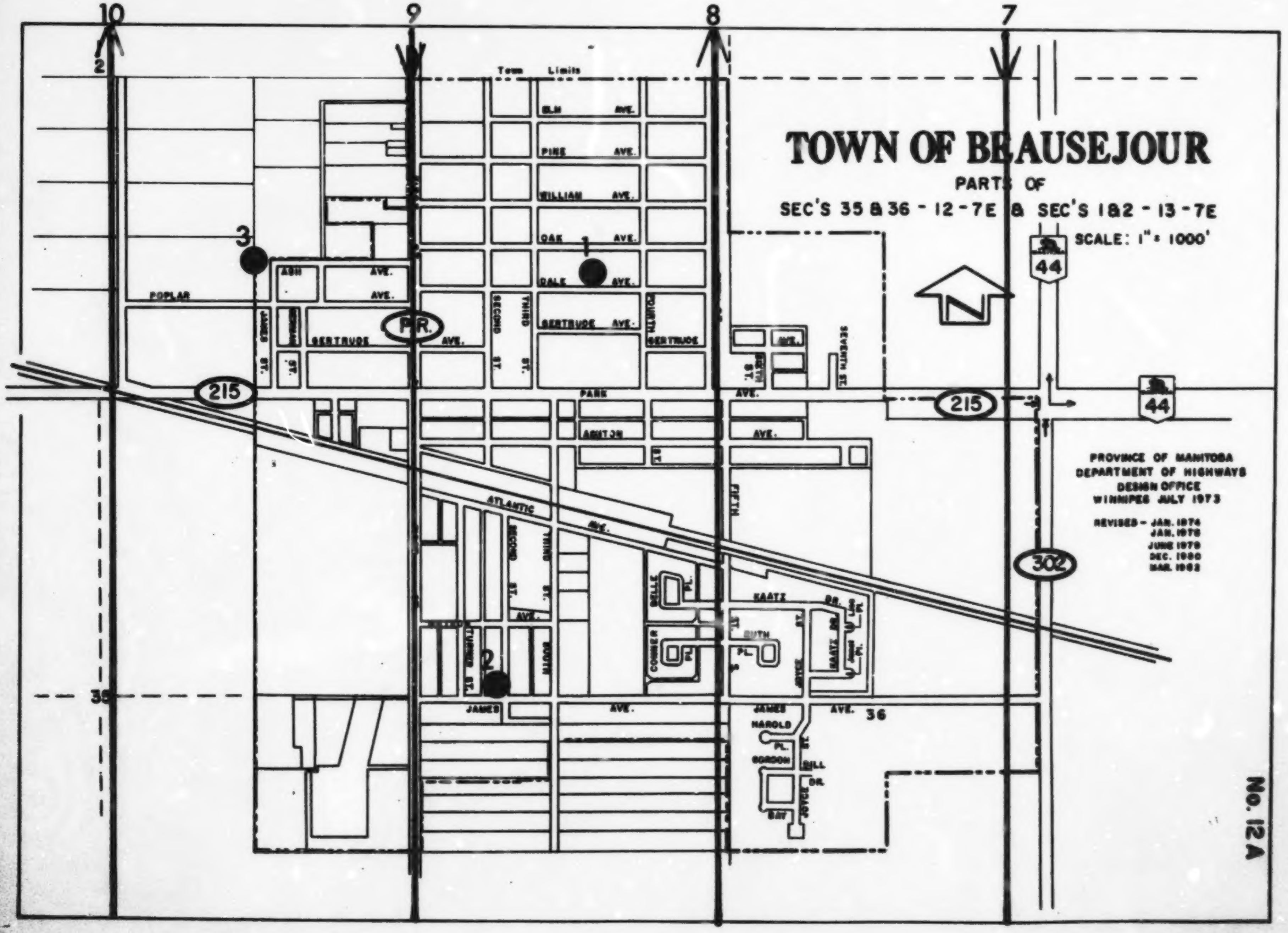
Nº 71-A
N
PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
REVISED: FEB 1981
OCT. 1982
DESIGN OFFICE
WINNIPEG FEB. 1978
0 200 400 600 800
SCALE IN FEET
7
8
9
GOVERNMENT ROAD ALLOWANCE
TOWN LIMITS
LAGOON
30
N.W. 1/4 SEC. 8
TR 2 – RGE. 1 W.
N.E. 1/4 SEC. 8
TP. 2 – RGE. 1 W.
N.W. 1/4 SEC. 9
TR2 – RGE. 1 W.
RAILWAY
PACIFIC
CANADIAN
N.E.
10th. AVE. N.W.
10th. AVE. N.E.
7th. ST.
3rd. ST. N.E.
5th. ST. N.E.
7th. AVE. N.E.
1
2
3
6th. AVE. N.E.
S.W. 1/4 SEC. 8
TR. 2 – RGE. 1 W.
5th. AVE.
4th.
N.W.
ST.
ST. N.W.
3rd.
S.W. 1/4
SEC. 9
TR2 – RGE. 1 W.
5th. AVE. N.E.
4th. AVE. N.E.
WILLOW BAY
WILLOW
WILLOW
BAY
BAY
P.R.
3rd. AVE.
3rd. AVE. N.E.
2nd. AVE.
2nd. AVE. N.E.
MAIN ST.
5th.
201
CENTRE AVE. W.
CENTRE 201 AVE. E.
2nd. AVE. S.E.
S.W.
WESTWOOD
SUNFLOWER
CRES.
ST.
WESTWOOD
DR.
CRES.
REDWOOD
WESTWOOD
CRES.
3rd. ST. S.E.
3rd.
AVE. S.E.
1st.
2nd.
4th. AVE.
ASH ST.
BIRCH ST.
ELM ST.
MAPLE ST.
S.E.
4th.
4th. AVE. S.W.
1st ST.
BAY
SPRUCE
CRES.
ASH ST.
N.W. 1/4 SEC. 5
TP. 2 – RGE. 1 W.
2nd. ST. S.W.
SPRUCE
BAY
CRES.
POPLAR
DRIVE
N.W. 1/4 SEC. 4
TR2 – RGE. 1 W.
TOWN LIMITS

# TOWN OF BEAUSEJOUR

PARTS OF

SEC'S 35 & 36 - 12 - 7E & SEC'S 1&2 - 13 - 7E

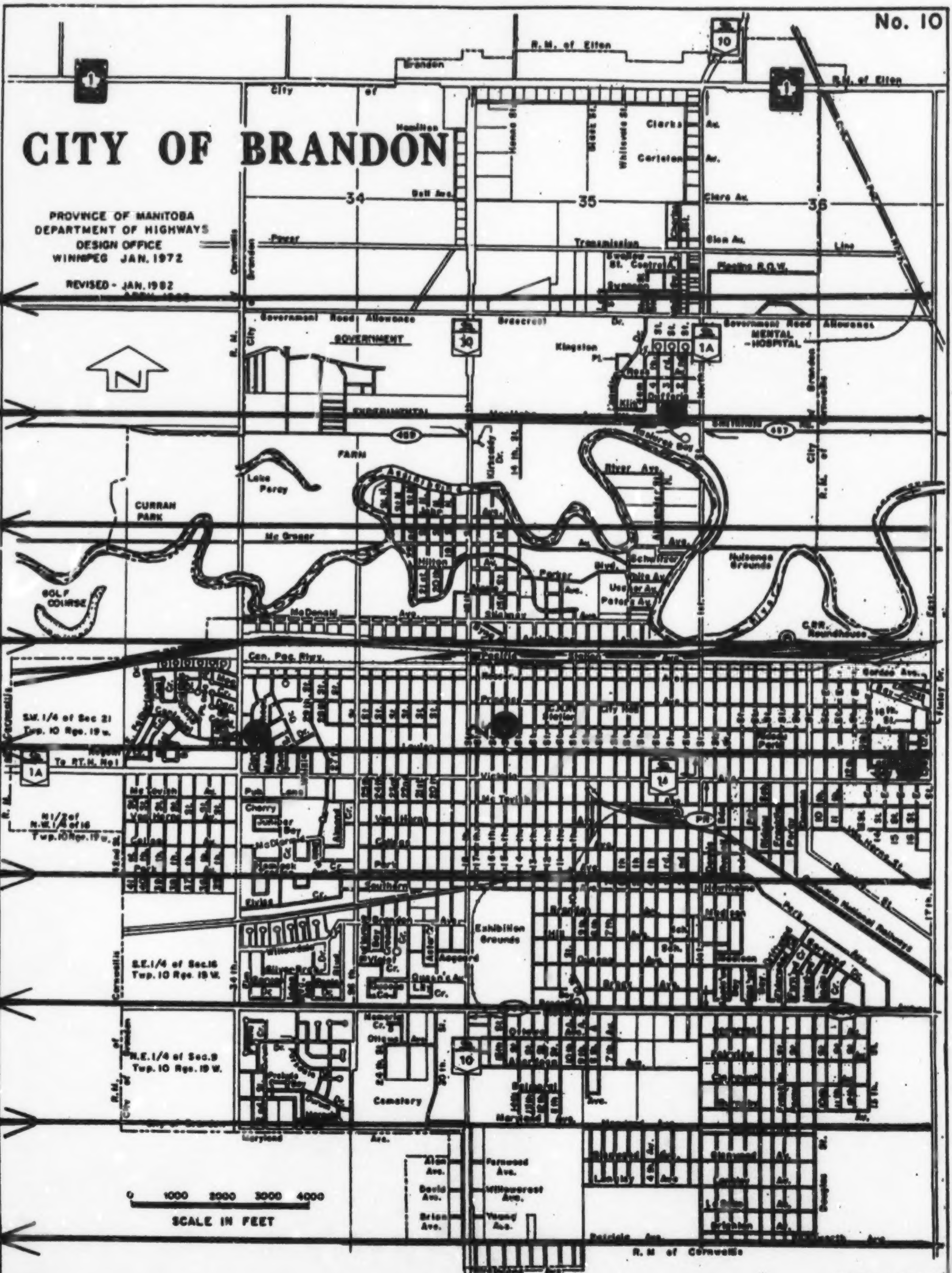
SCALE: 1" = 1000'

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
WINNIPEG JULY 1973

REVISED - JAN. 1974
JAN. 1976
JUNE 1979
DEC. 1980
MAR. 1982

No. 12A

10
9
8
7
2
Town Limits
ELM AVE.
PINE AVE.
WILLIAM AVE.
OAK AVE.
DALE AVE.
GERTRUDE AVE.
FOURTH
GERTRUDE
SECOND ST.
THIRD ST.
1
2
3
ASH AVE.
AVE.
POPLAR
JAMES ST.
GERMAN ST.
GERTRUDE AVE.
P.R.
215
PARK AVE.
ASHTON AVE.
ST.
SIXTH ST.
AVE.
SEVENTH ST.
44
ATLANTIC AVE.
FIFTH
SECOND ST.
THIRD ST.
AVE.
SOUTH
TURNER ST.
JAMES AVE.
BELLE PL.
CONNER PL.
KAATZ DR.
RUTH PL.
ST.
JOYCE
KAATZ DR.
HAROLD PL.
GORDON
GILL DR.
BAY
JOYCE
36
35
302
N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# CITY OF BRANDON

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
WINNIPEG JAN. 1972

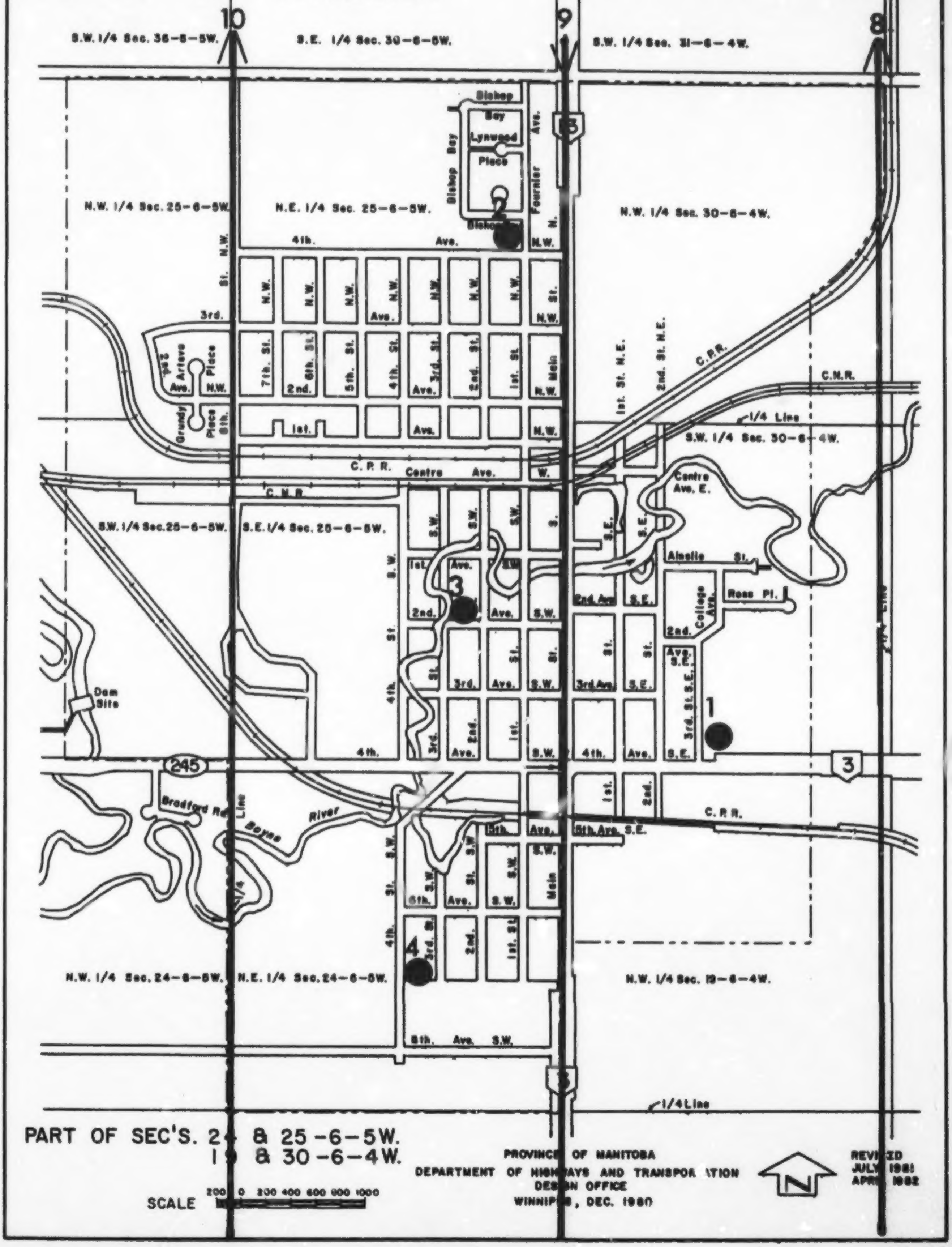
REVISED - JAN. 1982
APRIL

SHEET 1 OF 2

R.M. of Elton
Brandon
City of
Hamilton
Clarke Av.
Carleton Av.
34
35
36
Bell Ave.
Clare Av.
Power
Transmission
Line
Glen Av.
Pipeline R.O.W.
2
Government Road Allowance
Braecrest Dr.
GOVERNMENT
EXPERIMENTAL
FARM
Kingston Pl.
MENTAL HOSPITAL
3
Lake Percy
CURRAN PARK
River Av.
4
McGregor
Hilton Av.
Parker Blvd.
Schultz
Nuisance Grounds
GOLF COURSE
McDonald Av.
Stickney
C.P.R. Roundhouse
5
Can. Pac. Rlwy.
Rosser
Princess
CKX Station
City Hall
S.W. 1/4 of Sec 21 Twp. 10 Rge. 19 W.
6
Louise
To P.T.H. No1
1A
10
459
457
1A
McTavish Av.
Van Horne
Lorne
Victoria
Cherry
Rubber Bay
College
Park
7
N1/2 of N.W.1/4 of Sec16 Twp. 10 Rge. 19 W.
Southern
Elvina Cr.
Brandon Av.
Richmond
Exhibition Grounds
Rosser
Aberdeen
Queen's Av.
Canadian National Railways
S.E.1/4 of Sec.16 Twp. 10 Rge. 19 W.
8
Cornwallis
Ottawa Av.
Cemetery
N.E.1/4 of Sec.9 Twp. 10 Rge. 19 W.
9
Maryland Av.
Alan Ave.
Fernwood Ave.
David Ave.
Hillcrest Ave.
Brian Ave.
Young Ave.
Glenwood Av.
Lansdowne
Patricia Ave.
10
R.M. of Cornwallis
0 1000 2000 3000 4000
SCALE IN FEET
N

# TOWN OF CARMAN

No. 23A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9
8
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S.E. 1/4 Sec. 30-6-5W.
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N.W. 1/4 Sec. 25-6-5W.
N.E. 1/4 Sec. 25-6-5W.
N.W. 1/4 Sec. 30-6-4W.
Bishop
Bay
Lynwood
Place
Bishop Bay
Fournier Ave.
2
4th. Ave. N.W.
3rd. Ave. N.W.
2nd. Ave. N.W.
1st. Ave. N.W.
7th. St.
6th. St.
5th. St.
4th. St.
3rd. St.
2nd. St.
1st. St.
N.W. Main St.
Grundy Place
Artlove Place
1st. St. N.E.
2nd. St. N.E.
C.P.R.
C.N.R.
1/4 Line
S.W. 1/4 Sec. 30-6-4W.
Centre Ave. W.
Centre Ave. E.
S.W. 1/4 Sec. 25-6-5W.
S.E. 1/4 Sec. 25-6-5W.
Ainslie St.
Ross Pl.
College Ave.
3
2nd. Ave. S.W.
2nd. Ave. S.E.
3rd. Ave. S.W.
3rd. Ave. S.E.
4th. Ave. S.W.
4th. Ave. S.E.
3rd. St. S.E.
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Dam Site
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3
Bradford Rd.
Line
Boyne River
C.P.R.
5th. Ave. S.E.
6th. Ave. S.W.
4
N.W. 1/4 Sec. 24-6-5W.
N.E. 1/4 Sec. 24-6-5W.
N.W. 1/4 Sec. 19-6-4W.
8th. Ave. S.W.
1/4 Line
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19 & 30-6-4W.

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PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
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WINNIPEG, DEC. 1980

REVISED
JULY 1981
APRIL 1982

No. 21 A

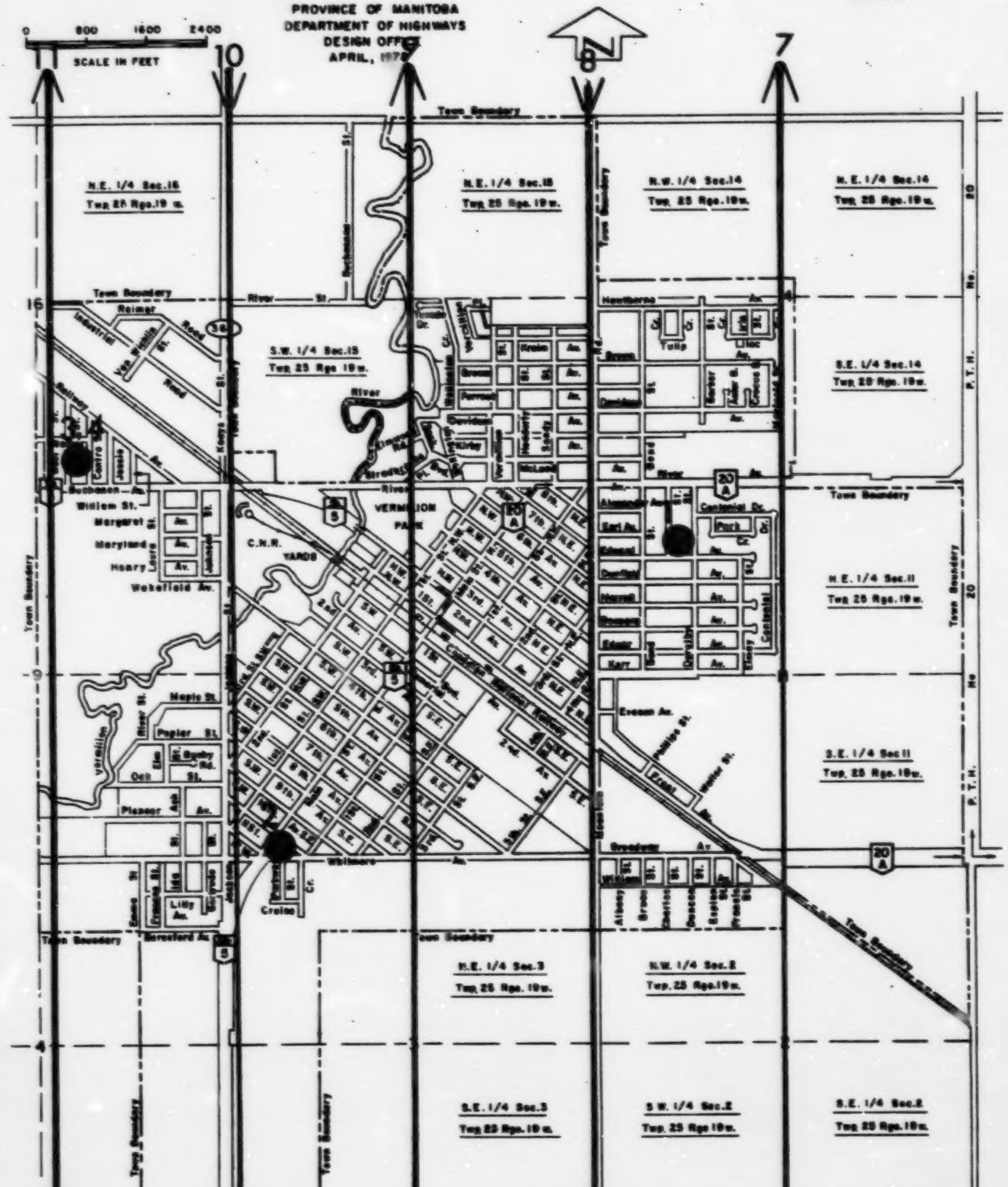
# TOWN OF DAUPHIN

IN SEC'S. 10, 11. AND IN PARTS OF SEC'S. 2, 3, 4, 9, 14, 15 AND 16

ALL IN TWP. 25 RGE. 19 W

REVISIONS :- NOV. 1978
JULY 1980

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
APRIL, 1970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N.W. 1/4 Sec.14 Twp. 25 Rge. 19 w.
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S.W. 1/4 Sec.15 Twp. 25 Rge. 19 w.
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S.E. 1/4 Sec.11 Twp. 25 Rge. 19 w.
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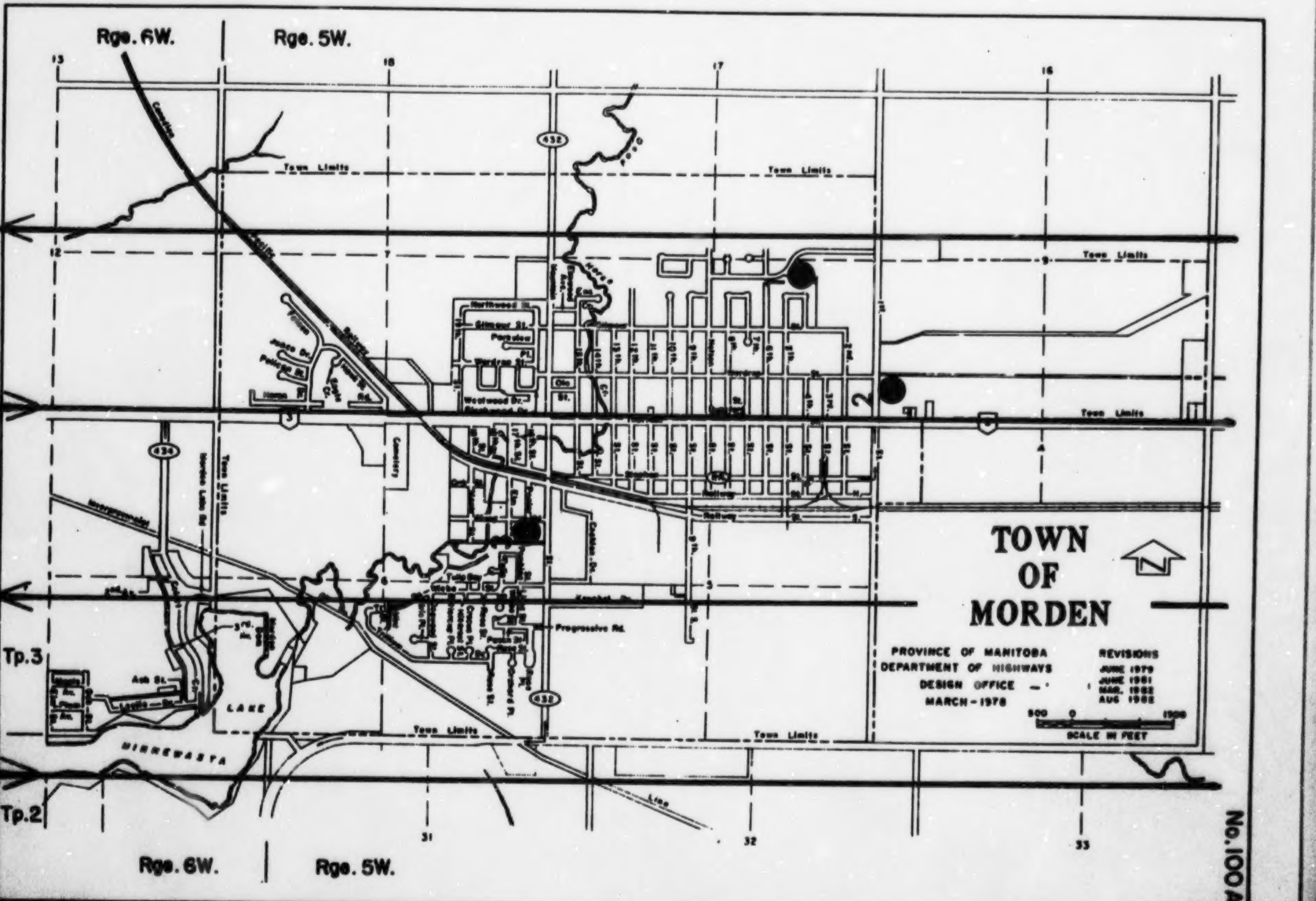
S.W. 1/4 Sec.2 Twp. 25 Rge. 19 w.
S.E. 1/4 Sec.2 Twp. 25 Rge. 19 w.
16
9
4
River St.
Hawthorne Av.
Reimer
Industrial Road
Railway
Buchanan Av.
William St.
Margaret
Maryland
Henry
Wakefield Av.
C.N.R. YARDS
VERMILION PARK
River
Vermilion River
Maple St.
Poplar St.
Pioneer Av.
Whitmore Av.
Crosie
Beresford Av.
Lilly Av.
Evason Av.
Fraser Av.
Broadway Av.
Centennial Dr.
Park Cr.
Alexander Av.
Earl Av.
Edward
Tulip
Lilac
Kings St.
Town Boundary
P.T.H. No. 20
5
20 A
3
2


Rge. 6W.
Rge. 5W.
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4
5
6
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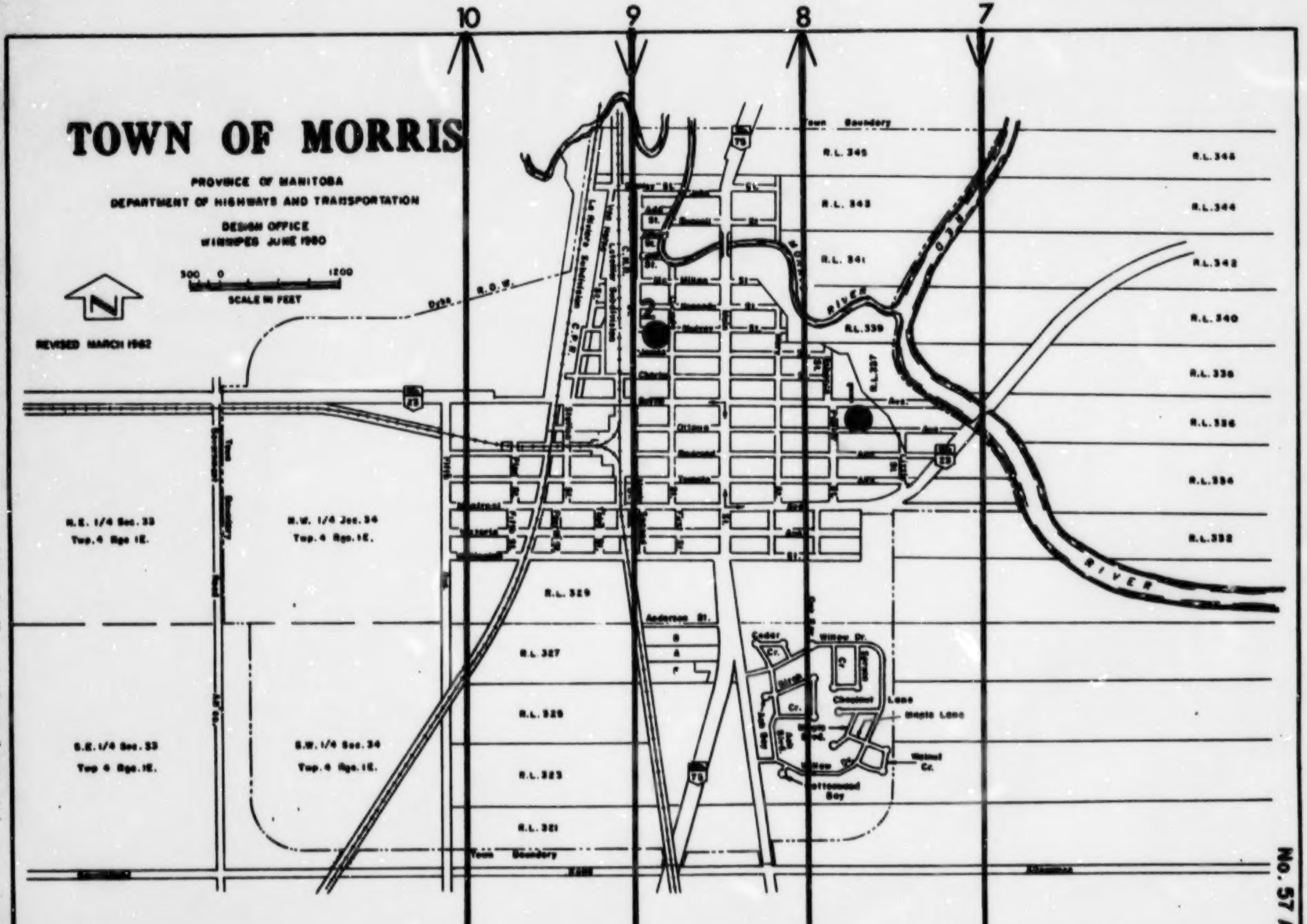
Tp.3
Tp.2
Town Limits
Cemetery
Railway
Norden Lake Rd
Progressive Rd.
Northwood Dr.
Gilmour St.
Parkview
Wardrop St.
Westwood Dr.
Nelson
Ash St.
Orchard Pl.
Rose St.
LAKE
MINNEWASTA
432
434
3
Line
SCALE IN FEET
500
0
1500

# TOWN OF MORDEN

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
MARCH - 1978

REVISIONS
JUNE 1979
JUNE 1981
MAR. 1982
AUG 1982

No.100A

10
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TOWN OF MORRIS
PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
DESIGN OFFICE
WINNIPEG JUNE 1980
300
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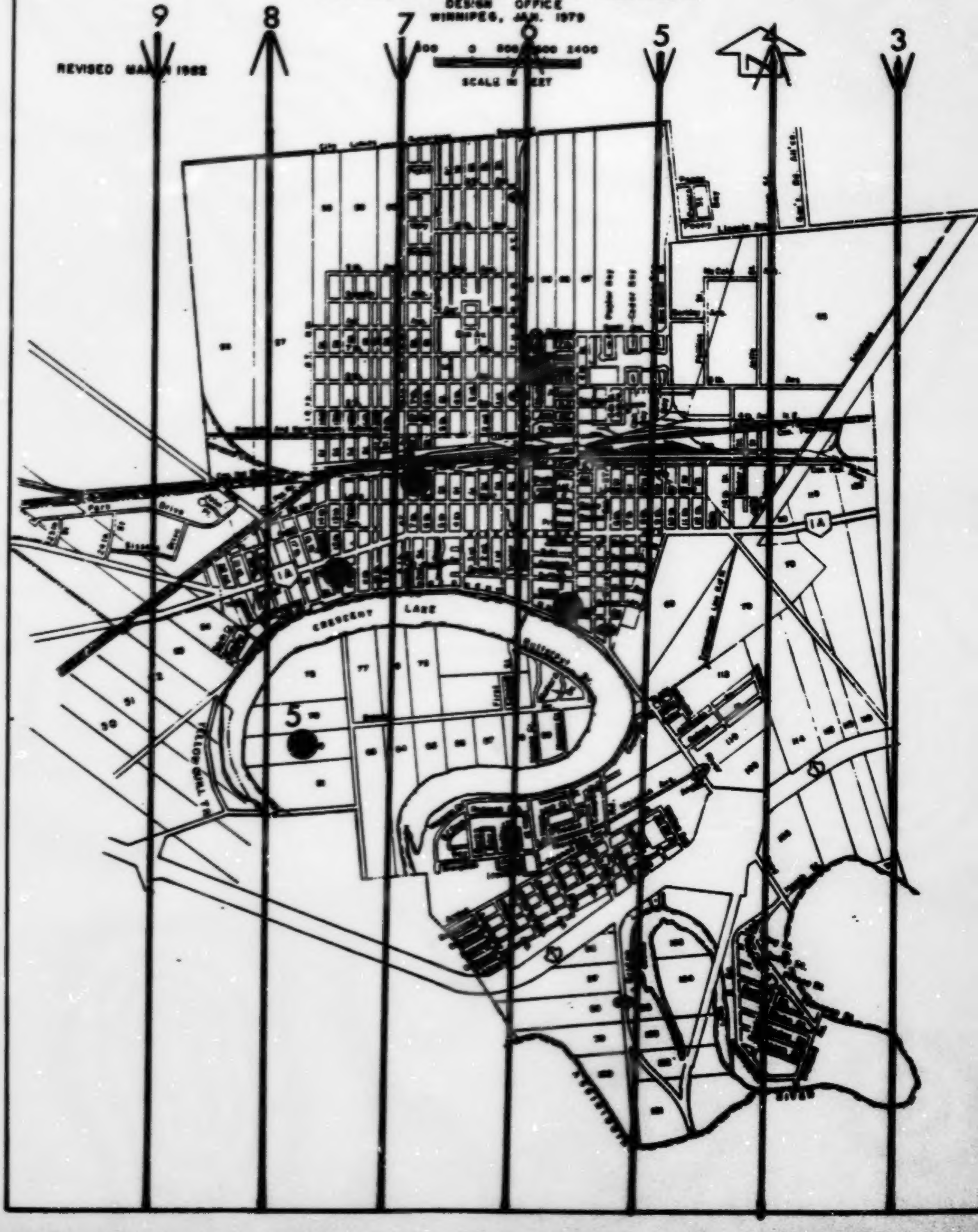
1200
SCALE IN FEET
N
REVISED MARCH 1982
Dyke R.O.W.
Town Boundary
R.L. 345
R.L. 343
R.L. 341
R.L. 339
R.L. 337
R.L. 346
R.L. 344
R.L. 342
R.L. 340
R.L. 338
R.L. 336
R.L. 334
R.L. 332
R.L. 329
R.L. 327
R.L. 325
R.L. 323
R.L. 321
MORRIS RIVER
RED RIVER
C.N.R.
Letellier Subdivision
La Riviere Subdivision
C.P.R.
Station
Ottawa
Charles
Anderson St.
Cedar Cr.
Willow Dr.
Spruce Cr.
Chestnut Lane
Maple Lane
Walnut Cr.
Cottonwood Bay
Ash Bay
Cr.
Birch
Maple Blvd.
Ash Blvd.
B
A
F
1
2
75
23
N.E. 1/4 Sec. 33 Twp. 4 Rge. 1E.
N.W. 1/4 Sec. 34 Twp. 4 Rge. 1E.
S.E. 1/4 Sec. 33 Twp. 4 Rge. 1E.
S.W. 1/4 Sec. 34 Twp. 4 Rge. 1E.
Town Boundary
Government Road Allowance
No. 57 A

No. 6

# CITY OF PORTAGE LA PRAIRIE

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
DESIGN OFFICE
WINNIPEG, JAN. 1979

REVISED MARCH 1982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4
3
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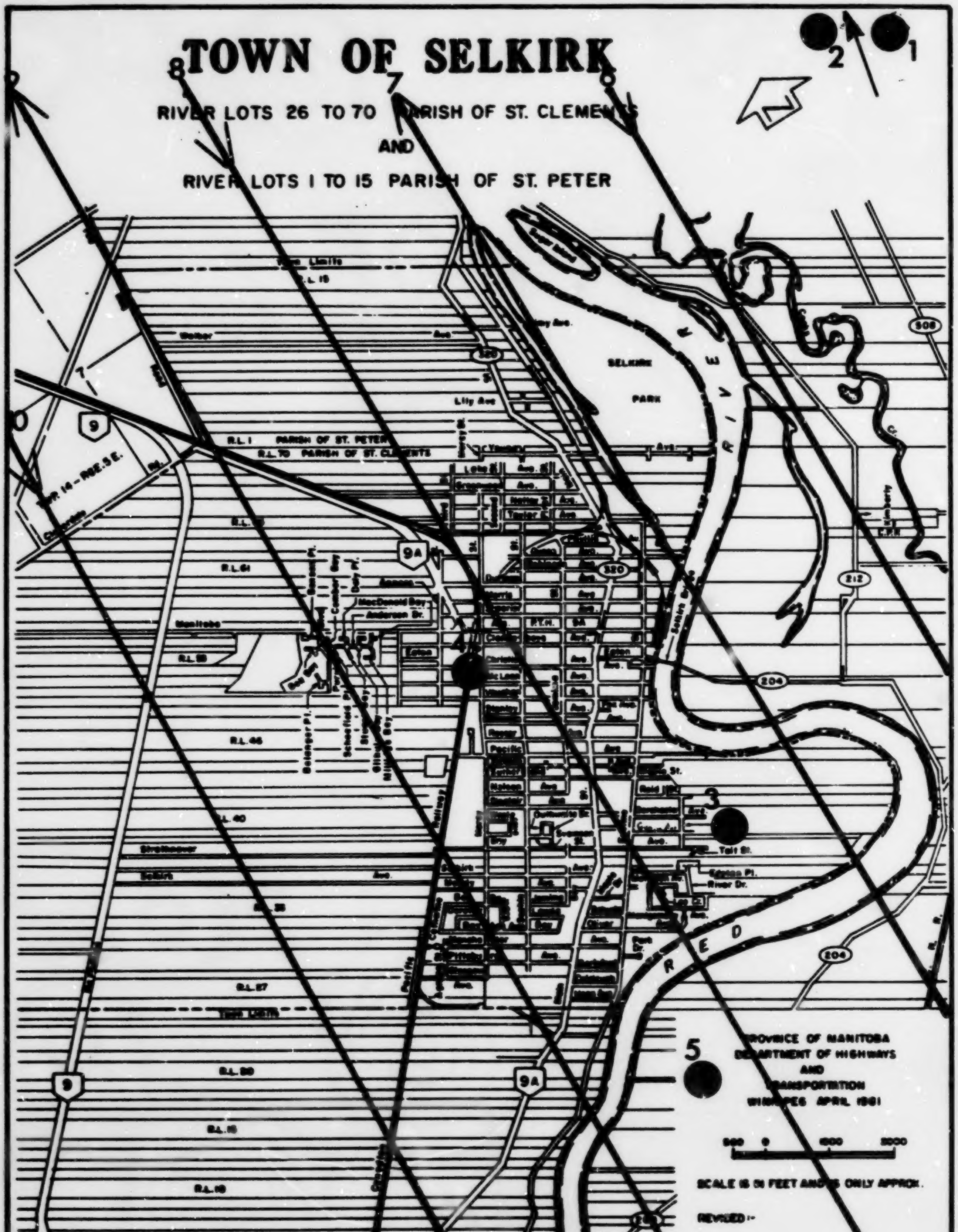
SCALE IN FEET
CRESCENT LAKE
1A
1A
5



TOWN OF SELKIRK

RIVER LOTS 26 TO 70 PARISH OF ST. CLEMENTS

AND

RIVER LOTS 1 TO 15 PARISH OF ST. PETER

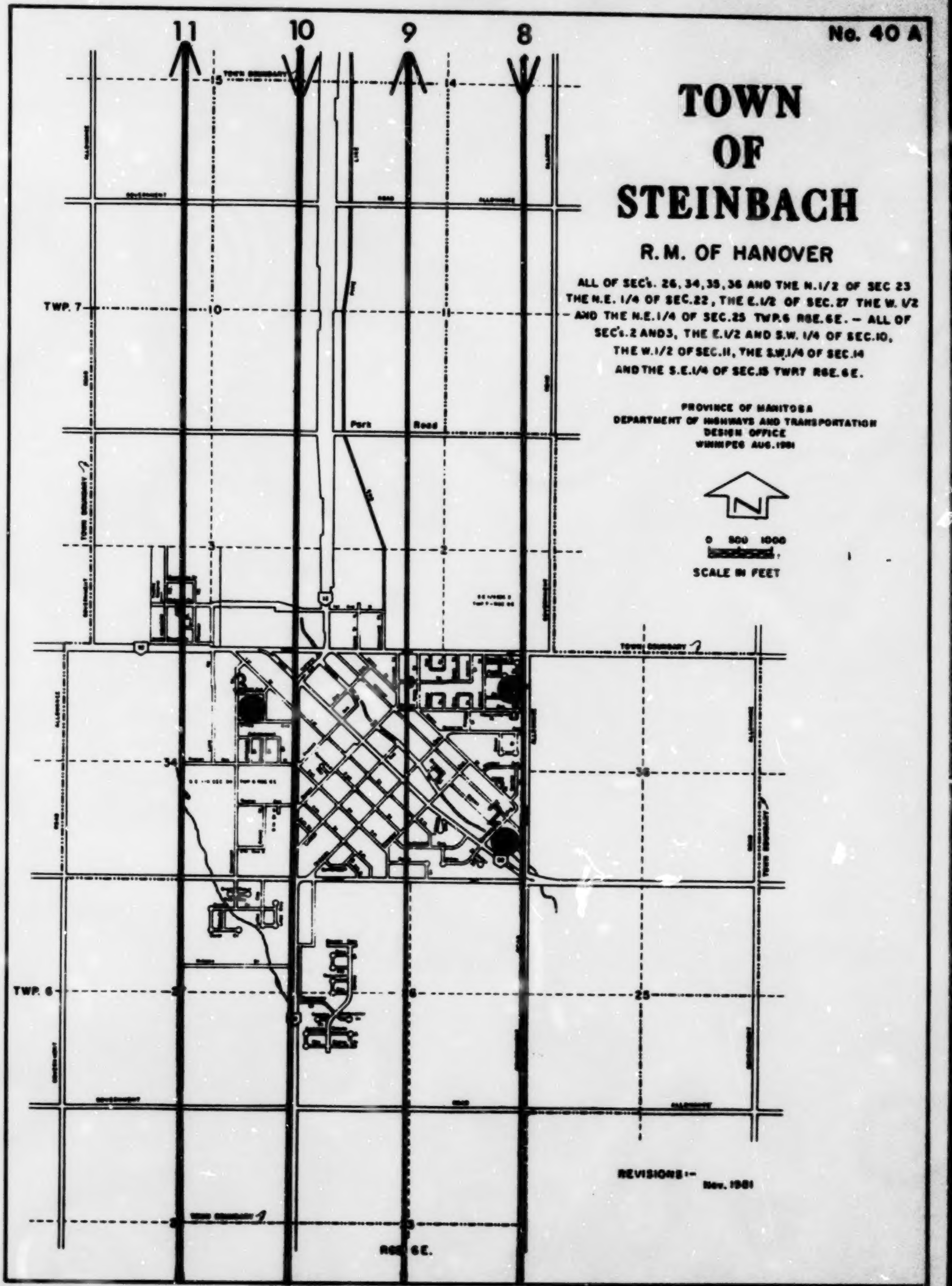
PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
AND
TRANSPORTATION
WINNIPEG APRIL 1981

SCALE IS IN FEET AND IS ONLY APPROX.

REVISED :-

SHEET 1 OF 2

1
2
3
4
5
6
7
8
9
Town Limits
R.L. 15
Walker Ave.
Lily Ave.
SELKIRK PARK
RED RIVER
R.L. 1 PARISH OF ST. PETER
R.L. 70 PARISH OF ST. CLEMENTS
Twp. 14 - RGE. 3 E.
R.L. 61
Manitoba
R.L. 55
R.L. 46
R.L. 40
Strathnaver
Selkirk Ave.
R.L. 35
R.L. 27
R.L. 20
R.L. 15
R.L. 10
MacDonald Bay
Anderson Dr.
Taylor Ave.
Eaton Ave.
Tait St.
Easton Pl.
River Dr.
Pacific
Selkirk Blvd.
C.P.R.
9
9A
320
204
212
508
500
0 1000 2000



11
10
9
8
TOWN BOUNDARY
15
14
GOVERNMENT
ROAD
ALLOWANCE
TWP. 7
10
11
Park Road
3
2
34
35
TWP. 6
27
26
25
TOWN BOUNDARY
3
2
RGE 6E.
0 500 1000
SCALE IN FEET

No. 40 A

# TOWN OF STEINBACH

## R.M. OF HANOVER

ALL OF SEC's. 26, 34, 35, 36 AND THE N.1/2 OF SEC 23
THE N.E. 1/4 OF SEC.22, THE E.1/2 OF SEC.27 THE W. 1/2
– AND THE N.E.1/4 OF SEC.25 TWP.6 RGE.6E. – ALL OF
SEC's.2 AND3, THE E.1/2 AND S.W. 1/4 OF SEC.10,
THE W.1/2 OF SEC.11, THE S.W.1/4 OF SEC.14
AND THE S.E.1/4 OF SEC.15 TWP.7 RGE.6E.

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
DESIGN OFFICE
WINNIPEG AUG.1981

REVISIONS:–
Nov. 1981

No. 75 A

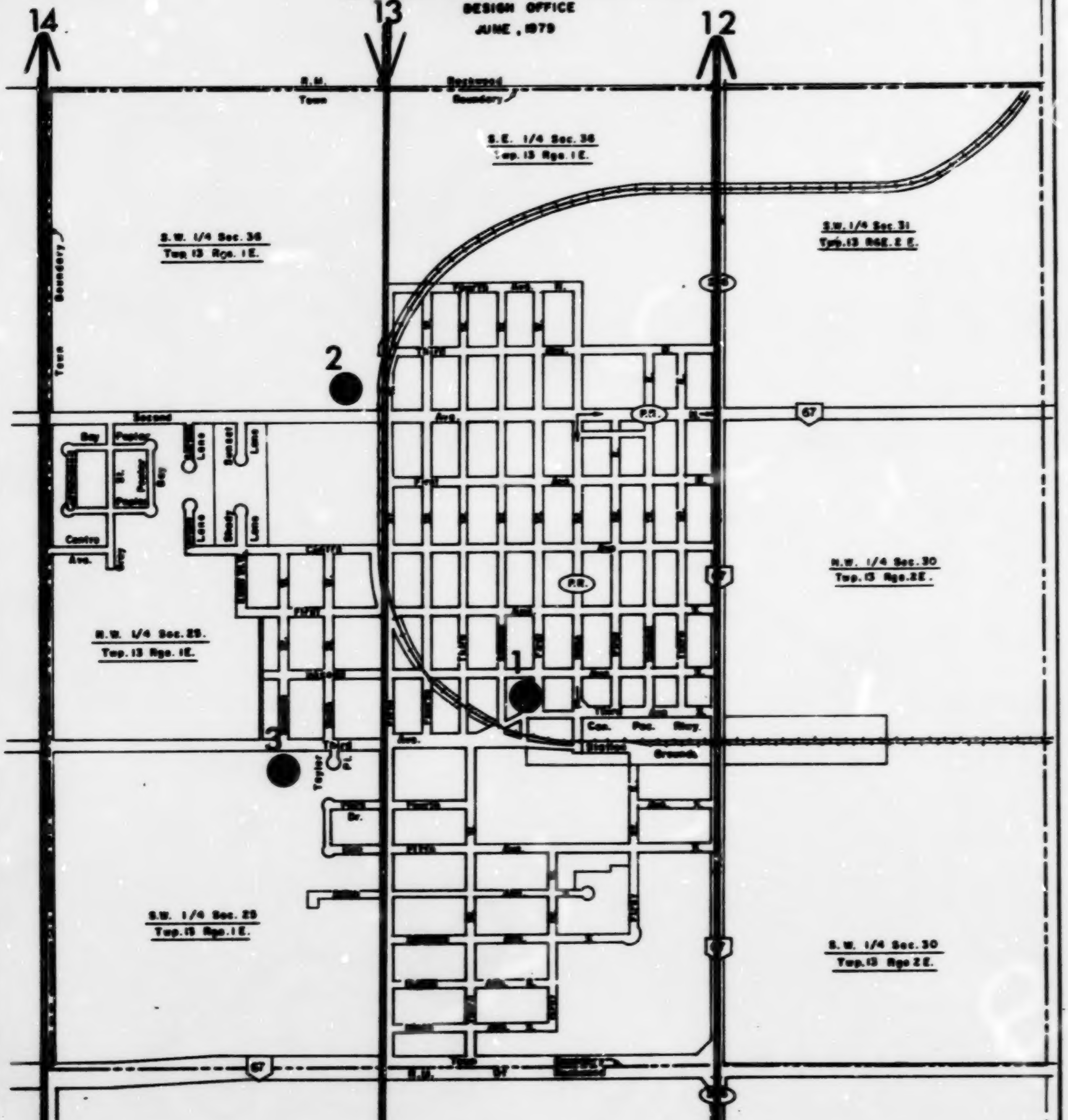
# TOWN OF STONEWALL

ALL OF SEC. 25 AND S. 1/2 SEC. 36 TWP. 13 RGE. 1 E
W. 1/2 SEC 30 AND S.W. 1/4 SEC. 31 TWP. 13 RGE. 2 E.

0 500 1000
SCALE IN FEET

REVISED:- AUG. 1982

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
DESIGN OFFICE
JUNE, 1979

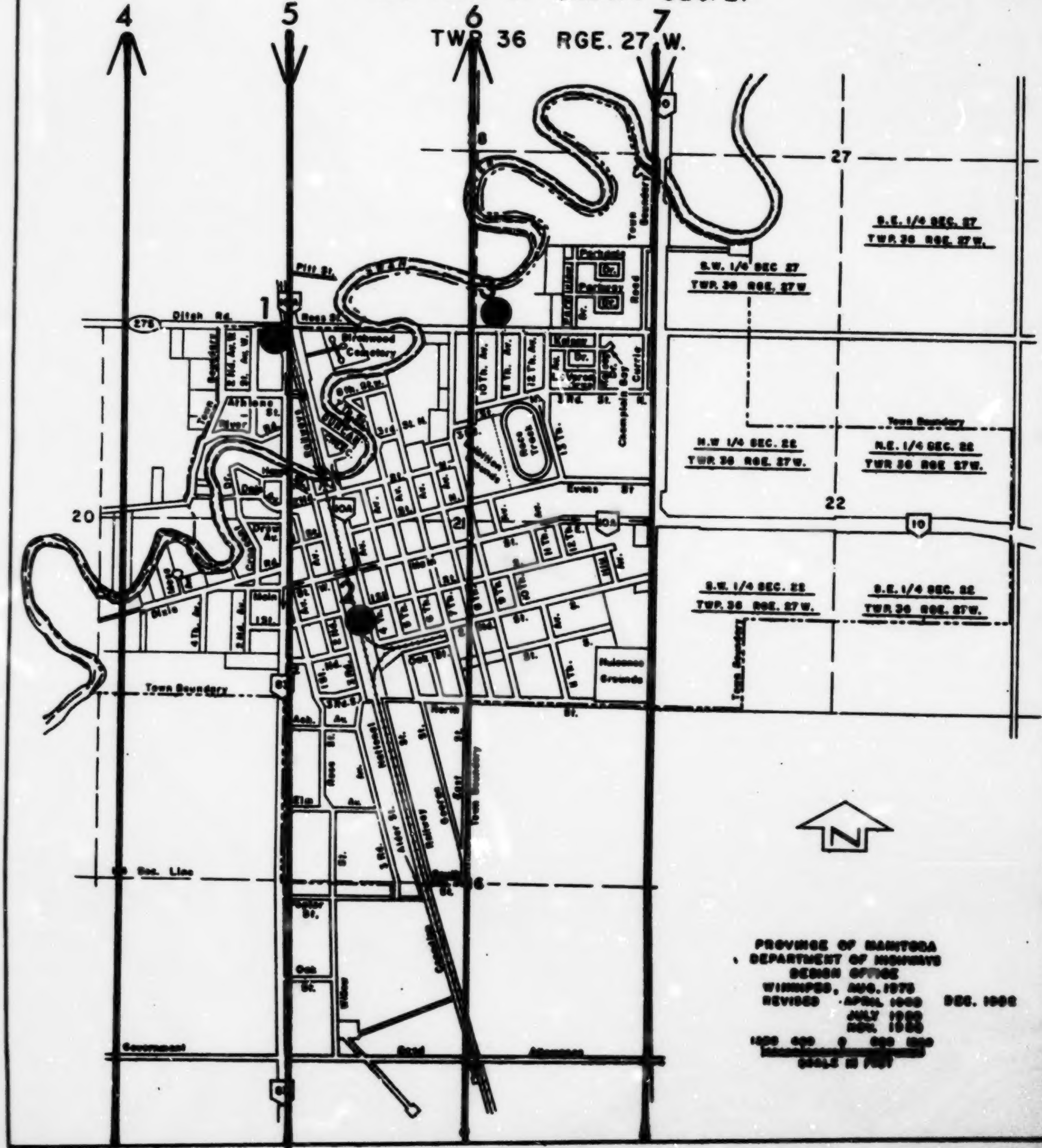

N
14
13
12
R.M.
Town
Rockwood
Boundary
S.E. 1/4 Sec. 36
Twp. 13 Rge. 1E.
S.W. 1/4 Sec. 36
Twp. 13 Rge. 1E.
S.W. 1/4 Sec. 31
Twp. 13 RGE. 2 E.
Town Boundary
2
Second
Ave.
P.R.
67
Bay
Poplar
Lane
Sunset
Lane
Shady
Lane
Centre
Ave.
N.W. 1/4 Sec. 30
Twp. 13 Rge. 2 E.
N.W. 1/4 Sec. 25
Twp. 13 Rge. 1E.
1
3
Third
Ave.
Taylor
Pl.
Can. Pac. Rlwy.
Station Grounds
Dr.
S.W. 1/4 Sec. 25
Twp. 13 Rge. 1 E.
S.W. 1/4 Sec. 30
Twp. 13 Rge 2 E.
R.M.

No.103 B

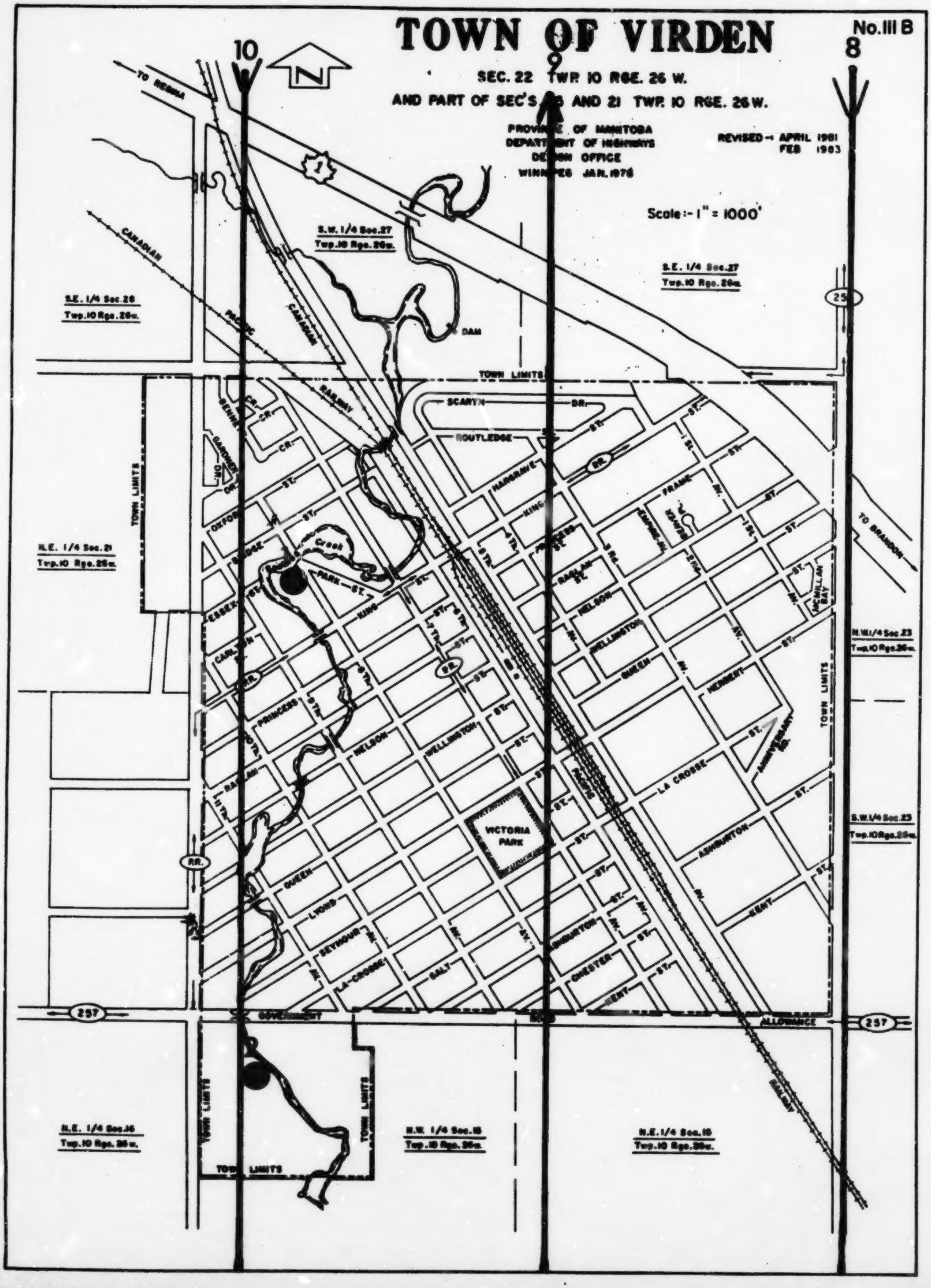
# TOWN OF SWAN RIVER

IN

SEC. 21, PART OF E. 1/2 SEC. 20
N.W. 1/4 SEC. 16, PART OF SEC. 22
AND PART OF S.W. 1/4 SEC. 27
TWP. 36 RGE. 27 W.


4
5
6
7
1
2
3
27
20
21
22
16
Ditch Rd.
Ross St.
Pitt St.
Swan River
Birchwood Cemetery
Town Boundary
Evans St.
Main St.
Race Track
Mulcahy Grounds
North St.
Railway
Aldor St.
Government Road Allowance
Sec. Line
S.E. 1/4 SEC. 27 TWP. 36 RGE. 27 W.
S.W. 1/4 SEC. 27 TWP. 36 RGE. 27 W.
N.W. 1/4 SEC. 22 TWP. 36 RGE. 27 W.
N.E. 1/4 SEC. 22 TWP. 36 RGE. 27 W.
S.W. 1/4 SEC. 22 TWP. 36 RGE. 27 W.
S.E. 1/4 SEC. 22 TWP. 36 RGE. 27 W.
10
10A
83
276
N

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
WINNIPEG, AUG. 1975
REVISED APRIL 19[illegible] DEC. 19[illegible]
JULY 19[illegible]
NOV. 19[illegible]
1000 500 0 500 1000
SCALE IN FEET



# TOWN OF VIRDEN

No. III B

SEC. 22 TWP. 10 RGE. 26 W.

AND PART OF SEC'S [illegible] AND 21 TWP. 10 RGE. 26 W.

PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
WINNIPEG JAN. 1976

REVISED – APRIL 1981
FEB 1983

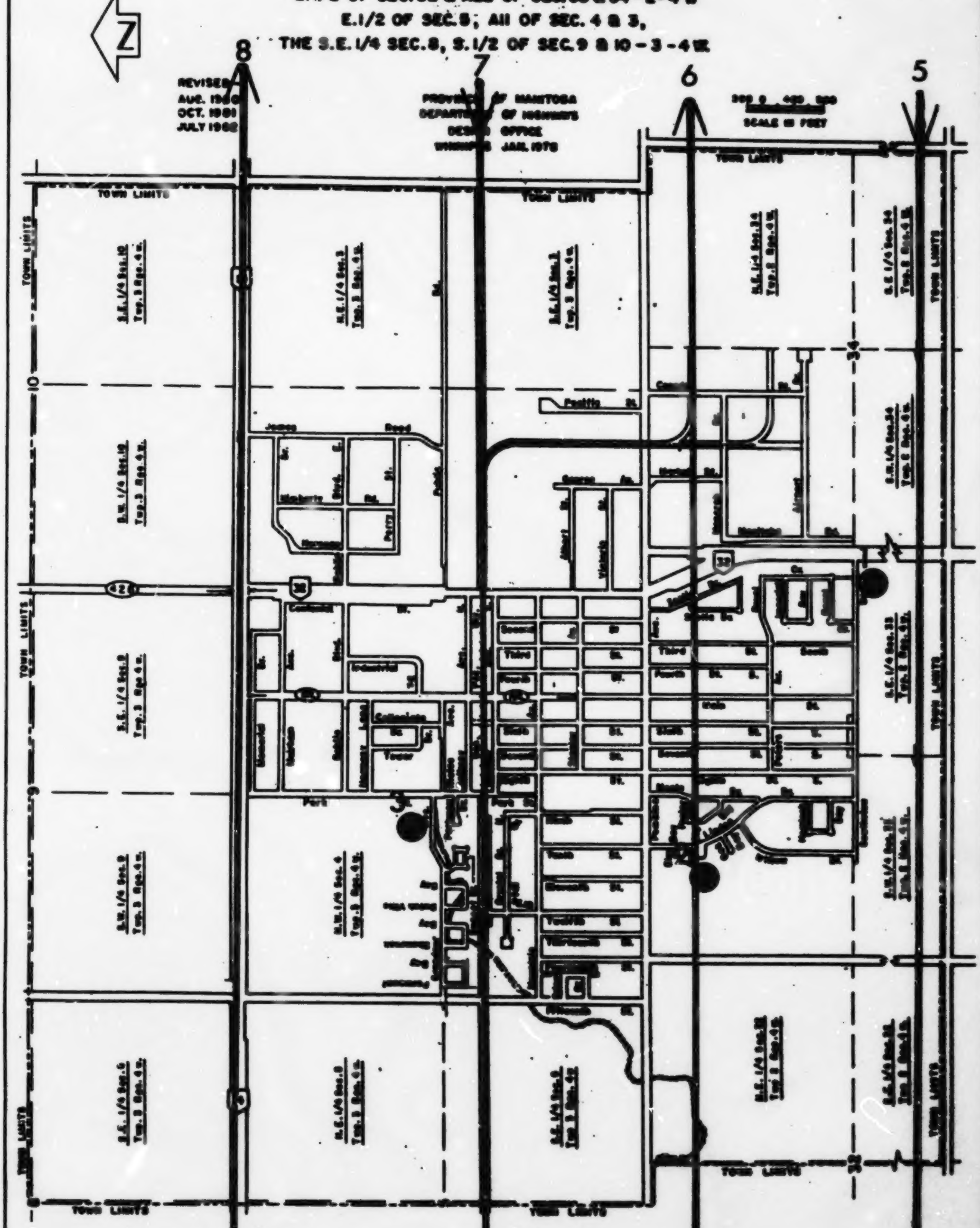
Scale:- 1" = 1000'

10
9
8
N
TO REGINA
1
CANADIAN PACIFIC RAILWAY
CANADIAN
S.W. 1/4 Sec.27 Twp.10 Rge.26w.
S.E. 1/4 Sec.27 Twp.10 Rge.26w.
S.E. 1/4 Sec.28 Twp.10 Rge.26w.
N.E. 1/4 Sec.21 Twp.10 Rge.26w.
N.W. 1/4 Sec.23 Twp.10 Rge.26w.
S.W. 1/4 Sec.23 Twp.10 Rge.26w.
N.E. 1/4 Sec.16 Twp.10 Rge.26w.
N.W. 1/4 Sec.15 Twp.10 Rge.26w.
N.E. 1/4 Sec.15 Twp.10 Rge.26w.
257
DAM
TOWN LIMITS
SCARTH DR.
ROUTLEDGE ST.
HARGRAVE
KING
PRINCESS
RAGLAN ST.
NELSON
WELLINGTON
QUEEN
FRAME ST.
HERBERT
LA CROSSE
ASHBURTON
KENT
MCMILLAN BAY
TO BRANDON
RR.
OXFORD ST.
BRIDGE ST.
ESSEX ST.
CARLTON
PARK ST.
Scallion Creek
VICTORIA PARK
LYONS
SEYMOUR
SALT
CHESTER
GOVERNMENT ROAD ALLOWANCE
RAILWAY
PACIFIC

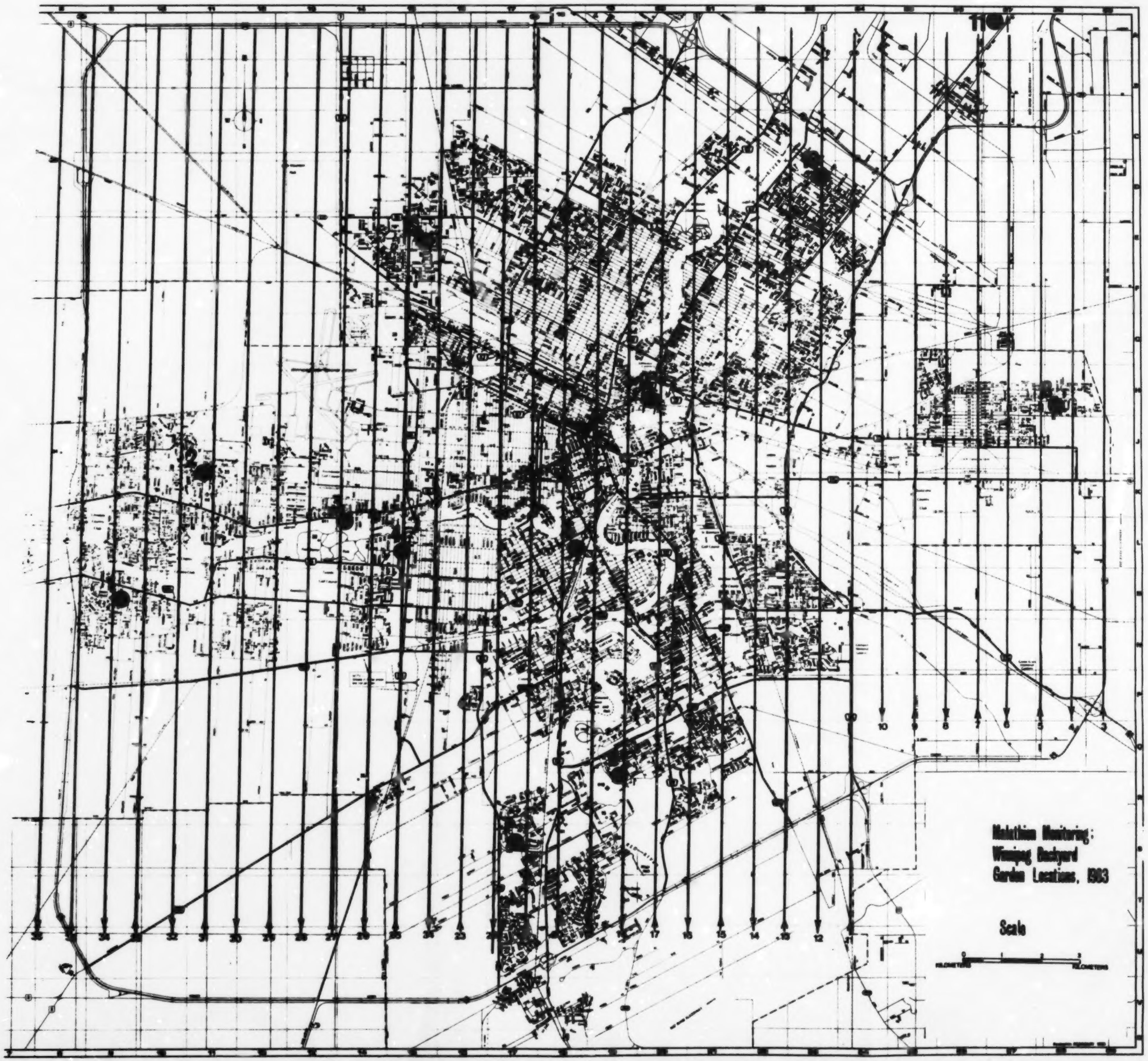
No. 100 B

# TOWN OF WINKLER

E.1/2 OF SEC. 32 & ALL OF SEC. 33 & 34-2-4 W
E.1/2 OF SEC. 5; All OF SEC. 4 & 3,
THE S.E. 1/4 SEC. 8, S.1/2 OF SEC. 9 & 10-3-4 W.



N
8
7
6
5
REVISED
AUG. 1960
OCT. 1961
JULY 1962
PROVINCE OF MANITOBA
DEPARTMENT OF HIGHWAYS
DESIGN OFFICE
WINNIPEG JAN. 1978
SCALE IN FEET
TOWN LIMITS
10
9
34
32
Pacific St.
James Road
Second
Third
Fourth
Main
Sixth
Park
Eighth
Ninth
Tenth
Eleventh St.
Twelfth St.
Thirteenth St.
Manitoba St.
32
42


Malathion Monitoring:
Winnipeg Backyard
Garden Locations, 1983
Scale
0
1
2
3
KILOMETERS
KILOMETERS
35
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3